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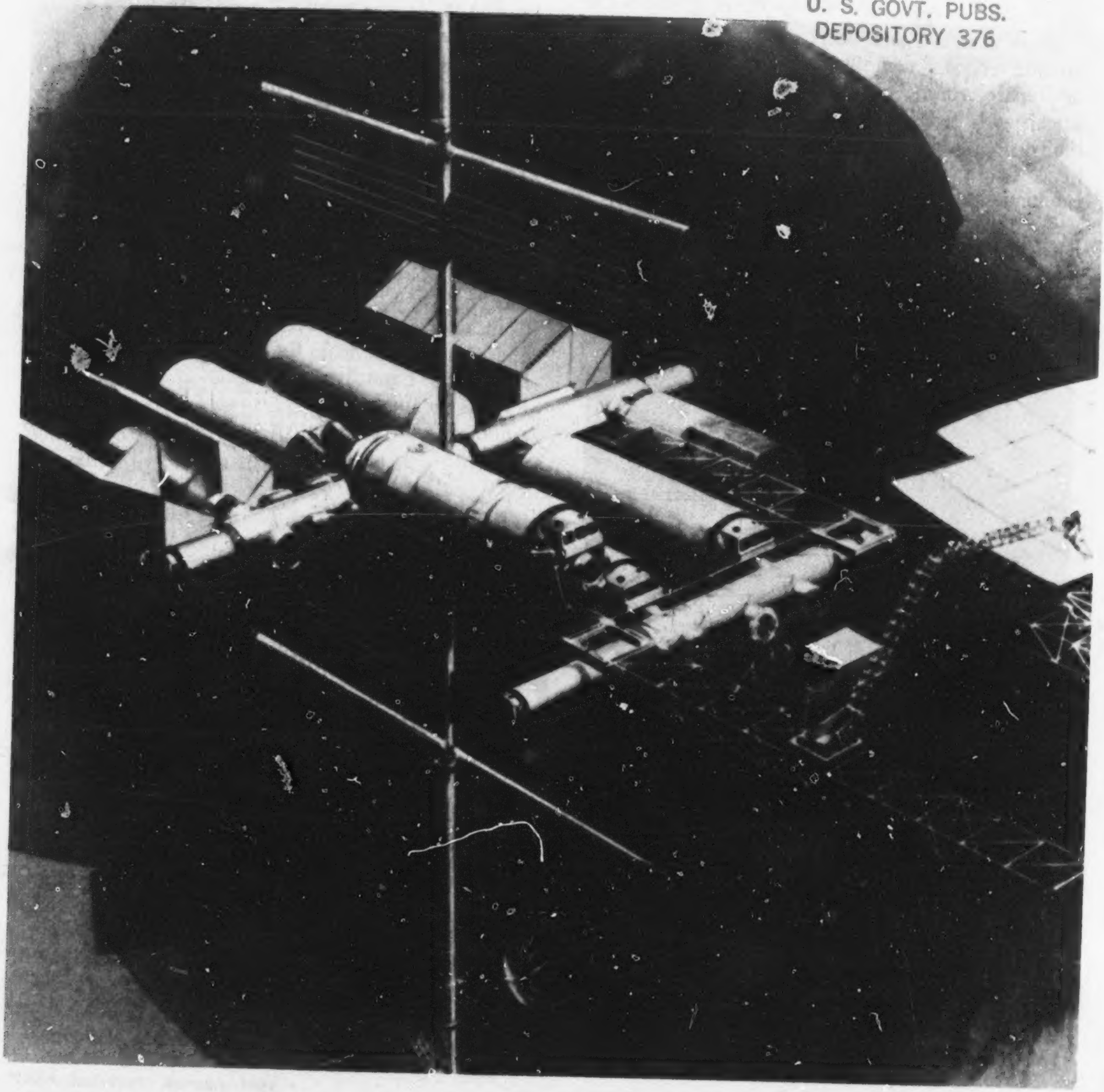

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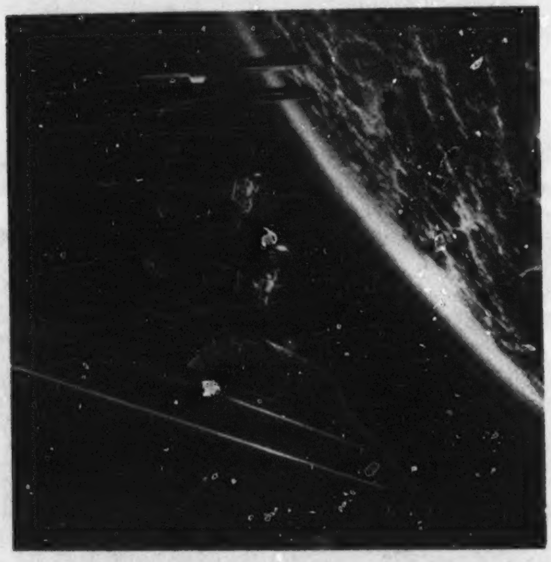
About the Cover

Designer's concept of an advanced Space Operations Center showing some of the modules that would comprise the system. Under contract with NASA's Johnson Space Center, Houston, Boeing Aerospace Company is studying the feasibility of such a station. Two habitat modules with viewing windows in the middle of the artwork would serve as living quarters and command control quarters for a normal crew of eight. The module above the habitat modules is a manned Orbital Transfer Vehicle which could take payloads from low Earth orbit to a higher orbit in space.

Below is an artist's concept of an outerspace satellite service system that would repair, refurbish or prepare orbiting spacecraft for return to earth. Lockhead Missiles & Space Co., Inc., is investigating the feasibility of such a system for NASA's Johnson Space Center, Houston. The study centers on what economic benefits will be gained from using the Space Shuttle to operate a satellite service system, what kinds of cargo containers must be developed to hold satellites destined for earthside refurbishment, and what kinds of maintenance services must be available for specific satellites.



Correction—On page 5 of the November 1981 issue of *NASA Activities* the painting shown at page bottom was incorrectly identified. It should have been cited as "Morning Thunder", an oil painting by artist Wilson Hurley, depicting the first launch of the Space Shuttle *Columbia* on April 12, 1981.

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Letter from Washington

For this issue of *NASA Activities* in 1982, I wanted to address all of you on what I believe is NASA's role, both now and in the future.

Basically, NASA's role will remain what it has been in the past—a continued balanced program in space exploration, manned space flight, aeronautics and applications. However, as to what level these activities will take place is a harder question. In real terms, in the last 10 years the NASA budget has decreased about 20 to 25 percent. The hope is that sometime in the next few years to get that downward trend turned up and instead of spending on the order of $6 or 6.5 billion, to spend the equivalent of about 5 years ago—about $7 or $7.5 billion, which gets us back to approximately one percent of the federal expenditure level.

Even considering OMB's budgetary targets, I believe this is a realistic expectation. A number of things have developed in the last two or three years that support this belief. One of these is an increased realization by the general public, as well as by specific constituencies, that the United States is not doing the necessary activity to maintain our technological lead in the world. I think the public perceives that the loss of competitiveness of American industry, and the decline in research and development expenditures in general, have resulted in foreign countries starting to move ahead of us. A further perception is that the Europeans and Japanese are somehow coming along faster than we are in accelerating their activities broadly in the research and development areas.

This perception translates into aiding NASA in its mission with the result that the NASA program, which happens to be the most visible research and development program in the federal government and in the country, has become more popular. Recent polls indicate that the majority of the public thinks what NASA's doing is proper and right, and that we should spend at least that amount of money on space research and technology development.

Moreover, a Harris Poll indicates that 40 percent of the public thinks we should be spending more—the highest percentage in the history of our agency—even in the halcyon days of Apollo, when NASA was very popular. So I believe that all of these things have convinced the public that perhaps we're not doing enough. And I believe this public realization represents a constituency.

I think that's a good sign because that usually transfers itself into politics. For example, a Presidential candidate in 1984 could give platform support for fiscal responsibility and control of the federal budget while also maintaining that research and development in the United States has been neglected and that the country should be spending more in this area, particularly as expressed in the space and aeronautics program. I think that would get a very positive response from the electorate.

In fact, this statement exists in the 1980 Republican platform. And I remind people in the Administration of this all the time.

The problem that this Administration is having is that the number one item on the agenda is cutting the federal budget. The feeling is that they can hardly cut food stamps and not cut, to some extent, the space program. It's as simple as that. That's the general rationale as to why we're getting cut along with everyone else.

The public perception that I would like to see corrected regards research and development abroad and the thought that the United States has lost its lead role in this competition. This is not entirely true and this is a very complex arena. In space foreign competition is very strong in communications and will increase in remote sensing, while the Europeans are spending only on the order of $1 to $1.5 billion on their space activities. However, they are focusing that expenditure in very specific areas, areas where they feel they can get substantial payoff: in the Ariane launcher program, the SPOT Earth resources spacecraft and in the communications satellite field, where they now compete worldwide.

Currently there are four countries out for bid on a communications satellite. Three of them are in Central and South America and the other one is Australia. In all four of these, the French and the Japanese are competing and they are competing very effectively with technology as good as ours and with prices as good as ours, including the usual extras such as better financing. The communications satellite field is the first place that they have moved into what has been a U.S. monopoly. In other areas, however, the United States clearly dominates the world—in space technology and aeronautics. We also do well in cybernetics and in things like machine tools, but the industrial world is coming fast.

In other areas, however, we are losing ground as well, and it's because foreign nations are focusing their efforts in areas where they see a fairly sizeable commercial payoff. It is true that almost all of that is building upon foundations laid by NASA over the past couple of decades, which is of scant solace. You could make a sweeping generalization which, like all generalizations, is probably wrong—that the whole Japanese economy is based on American technology But they have taken that technology and moved it forward to make a very effective, highly competitive economy, one which has resulted in a vast increase in their standard of living and has resulted in an enormous competitive posture with the rest of the world.

As an open society, the United States publishes almost everything we do. Japan can use our technology; indeed, we have given it to them. In the past we went around the world passing off these very valuable gifts, like license-free use of all NASA technology.

This in turn raises a related question: When does NASA research and development become ready for commercial utilization? How and who makes the decision and at what stage does this transfer happen?

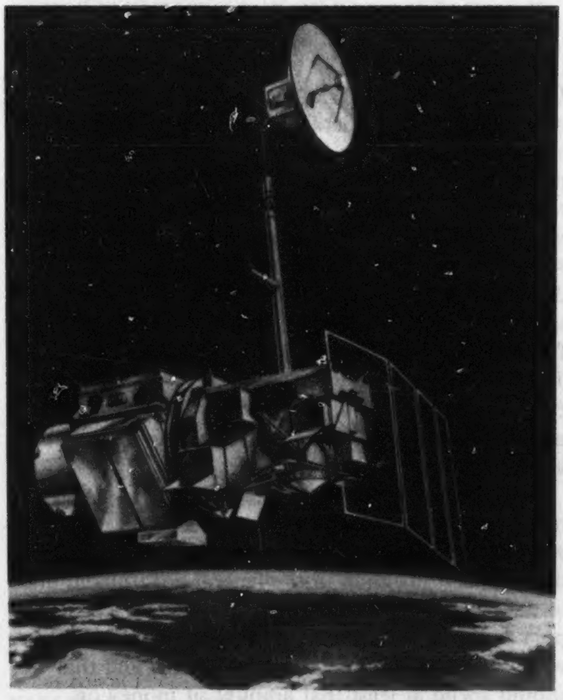
I've spent most of my life in business and timing of commercialization is the most difficult thing in the world to determine. The analog in the business world is the translation of technology into a new product and the marketing of that product. The problem is that "we" (meaning the country) don't know how to do that very well. The manifestation of that problem is some 80 or 90 percent of all new products fail in the commercial world. We have tried a lot of ways to improve that percentage: test market techniques, market studies, research as to requirements and needs and so forth. We must try to do the same thing here in NASA applications.

Landsat, as a current example, is something in which there was a lot of thought by NASA as to its potential commercial fallout. The conclusion was that there was a market, and indeed there is a market without any question. Is it a commercially viable market though? This is the second question you must ask yourselves. The problem is that a big part of the market are individuals who wouldn't otherwise pay the full cost of the data.

The largest Landsat user is the government. The other part of the market are commercial users. In their case they want, to some degree, confidentiality in the data they obtain. It's both a necessity and a hard requirement for most of them because, if they're going to use the data, for example in drilling a well, or in trying to exploit a natural resource, or for estimating crop yield, the large commercial users would like to be sure that that data is known only to them, since they must make very large investments.

To translate technology like Landsat into commercial reality, I believe we must rely on the entrepreneur, because this is the person who must decide whether a market can be developed around a specific system. Typically, we in the government are not very good entrepreneurs. NASA is very good at doing the basic research and understanding the system aspects. When it comes to trying to figure out whether there's a market or not, we don't do that very well.

And if you're going to attract entrepreneurs in the field then you've got to give them a fairly broad license to do with the system almost what they will. He's taking the risk; he's going out and raising the venture capital, and the government should encourage this process. The trouble with that is that it may turn out in a much different way than you expect, and you may not like the results. When you



Artist's concept of Landsat-D to be launched July 1982.

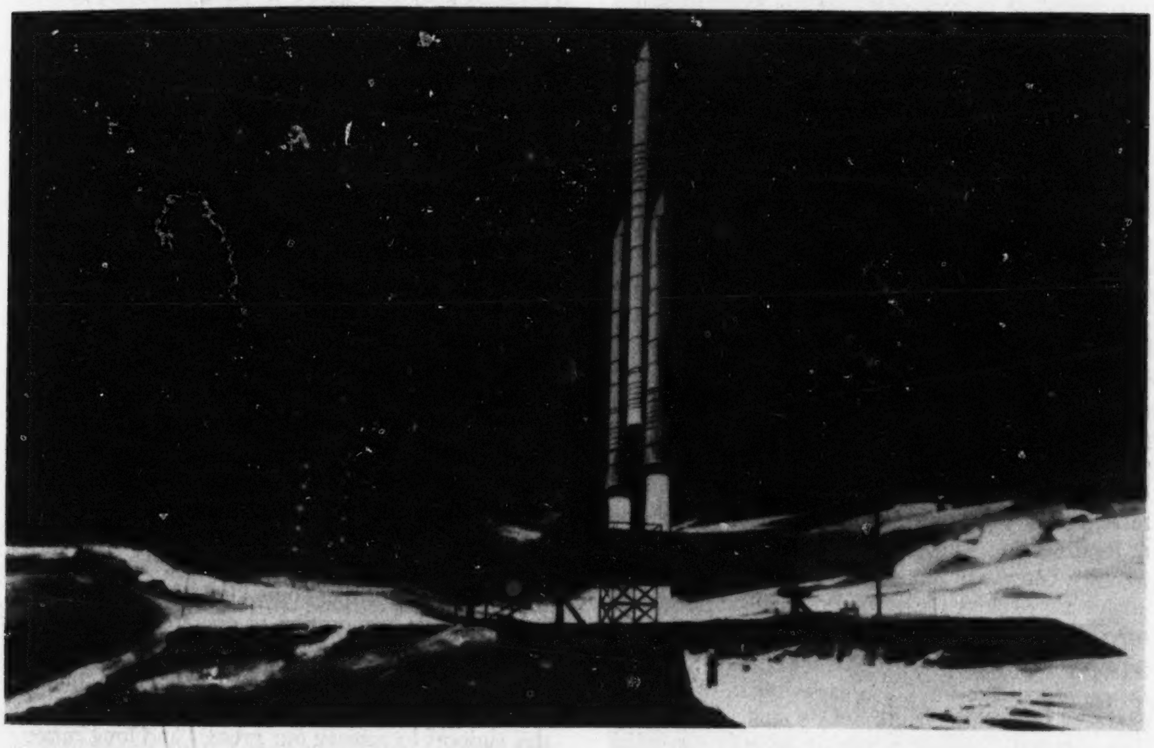
don't like the result, the only answer is to pass another law, hoping to enforce market sharing.

This, of course, would tend to make future entrepreneurs wary. That's why a lot of entrepreneurs are scared to death of the government anyway. In order to allay their fears we must encourage the private sector by easing regulation and control. For example, there are several bills before Congress right now on patent rights which I heartily support. If enacted, when a contractor develops a patent under government funding, royalty-free rights to develop this patent are granted. The only exception is that royalty-free rights also must be guaranteed to the government if the government wants to exercise this privilege, since the patent was developed with federal money.

The opposing view holds that it is the government money that provides the seed funding to get that idea into the public domain. And this is true. But it is also true that the patent is exploited and this creates economic activity that in turn benefits the nation. It also directly benefits Uncle Sam through taxes on the profits made from the commercialization.

All of this leads to the basic conclusion that if Congress wants to have a faster spinoff of the applications work NASA does, a broad statute must be written that provides a method of getting that application to the private sector which, in turn, will bring it into commercial reality. The government, of course, should retain royalty-free use of the data.

Next, I would like to address NASA's role for space science over the next decade. Most of you have read in various articles that NASA has very few programs planned for the future and, moreover, this program area is an easy target for budget cutters, despite public and Congressional support. The planned programs we have, in fact, are as much as



New Rocket Concept—Under study at NASA's Marshall Space Flight Center, Huntsville, Ala., is an unmanned launch vehicle called the SRB-X, which would be developed primarily from recoverable Space Shuttle components. In a "mixed fleet" concept which NASA is considering, the SRB-X would be used to augment Shuttle flights when payload space is not immediately available in the Orbiter. The "SRB" refers to the Solid Rocket Booster, that part of the Shuttle system which provides primary thrust at launch and falls back to Earth for recovery. In this artist's concept, a three-rocket SRB-X configuration lifts off to carry as much as 65,000 pounds of cargo into low Earth orbit. The payload would be located at the top of the center rocket, and after the payload was inserted into orbit the solid rocket boosters would fall back to Earth to be used once again.

we currently can afford. I would like to do a lot more. But interestingly, and I've been staring at budget numbers here for the last couple of months, if you look at percentages and forget about the absolute amount, space science has been getting about the same percentage of the budget since the Apollo days.

Now the problem is, from the point of view of real resources, that is a declining number. The figures as they work out reveal a steady-state condition if you go back to 1972, the completion of our Apollo expenditures. We were spending a budget for a core program—on the order of $3.3 to $3.4 billion in 1971 or 1972 dollars. Escalating that into 1982 dollars equals $7.5 billion. Congress now is ready to enact a NASA budget of $6 billion, $1½ billion short of a steady-state core program. That's the reason the space science share of the total budget is a lot less than they were obtaining in 1972, and that hurts.

If the NASA budget is cut further, and I trust it won't be, we would definitely have to cut into the space science program, because there is no other place to cut. Our endeavor over the next five years is to get back to a NASA budget that is a little closer to the one percent of government expenditures. That's a percentage I think is reasonable and not greedy for this agency.

To achieve this, NASA needs a new major goal to provide the program of technology which stimulates so much spinoff. The reason I and the Deputy Administrator (Hans Mark) have emphasized a space station as such a goal follows naturally in the Shuttle program—the program envisioned was not only transportation but a total system. The space shuttle provides the ability to carry a lot of weight up and a revisit capability. This ability leads you to start thinking of applications which require large structures, antenna systems, materials processing systems, or large systems with potential for power generation.

When you start talking about large structures, you've got to carry them up in pieces and put them together in orbit. And when you start to examine how you're going to do that, you really need a base; hence a space station. Once you're there, then you can start dreaming even bigger dreams.

In contemplating these possibilities, you can start seeing a huge system involving manned activity in using the three planet system of the Earth, Moon and Mars. Now you're out to the year 2050 or something like that, but you've got a continuing series of objectives set, each of which leads logically to the next. And such an expansive program of manned activity will not draw away from the space sciences. There is still a long list of initiatives that we would like to achieve in space science. And when you get to the point of having the space station and the ensuing capability of doing things in space, then a lot of that science becomes easier to obtain. The system becomes more logical in terms of what you have to do in order to launch the platforms to the place you want.

I do not believe that the future of space shuttle operations necessitates a split between military and civilian shuttles. However, if the Air Force feels in any way that it needs a degree of control that they feel they don't have, I'd be perfectly willing to give it to them for their flights. But I would object very much to splitting the fleet. I think that there's a lot of advantages to keeping the fleet together, both operational, economic and from the point of view of the improvement of the system as we go along. The flight rate that the Air Force is talking about is relatively low, and there's no reason why we can't draw key people out of Kennedy to assist them.

We will need five orbiters to effectively carry out the productive utilization of space. Sooner or later we will have operational failure and need back up vehicles standing by when we reach a high flight rate per year.

In the long-term, NASA is not an operating agency. That troubles people when you look at the rate of shuttle activity that may develop: 25 or 30 flights a year, flying 2 or 3 times a month. A flight rate of that magnitude is a large operational responsibility. My experience in the federal government tells me that agencies with large operational responsibilities inevitably neglect their research and development responsibilities. Operational responsibilities are day to day. You've got to pay attention to them which necessitates devoting less and less time to research and development.

So in the future, when the shuttle achieves full operational capability, it will be something that can be spun off into either some kind of quasi-public/private corporation or operate as a profit-making enterprise.

As always, our goal must be to keep our constituency behind America's space program. We need this support to achieve our present and long range goals.

Note: This speech was taken from a recent interview given by NASA Administrator James M. Beggs to Dr. Mark Chartrand and Leonard David from the National Space Institute. The interview appeared in the Institute's November/December edition of *Insight* magazine.

1981 in Review

Two successful flights of the Space Shuttle Columbia, Voyager 2's flyby of Saturn and a perfect launch record were among the highlights of 1981 for NASA.

Columbia's two missions, in April and November, marked a new era in space flight. It was the first time that a spacecraft has been launched from and returned to Earth and then reused for a second mission.

More spectacular photographs and new detail and scientific data resulted from the closest approach to the giant ringed planet of Saturn by NASA's Voyager 2 spacecraft late in August.

The Voyager 2 mission added to information already gained about Saturn from Voyager 1 which flew past the planet in November 1980. Voyager 1 is moving out of the ecliptic plane of the solar system while Voyager 2 will travel several billion more miles to a Uranus encounter in January 1986, then on to a rendezvous with Neptune in August 1989.

In addition to the two Shuttle missions, there were 11 other successful launches by the agency. The year's perfect launch record is the fifth in the agency's 23-year history. The launches ranged from weather and communications satellites to environmental monitoring and Sun-Earth energy studies.

Following are synopses of NASA's program achievements for 1981. In this edition of *NASA Activities*, we will cover the reports for the Space Transportation System, Space Transportation Operations, Space Tracking and Data Acquisition, Aeronautics, and Energy Research and Development. In the February edition of *NASA Activities*, we will conclude these summary reports with the program areas of Space Science and Applications and International Affairs.

Space Transportation System

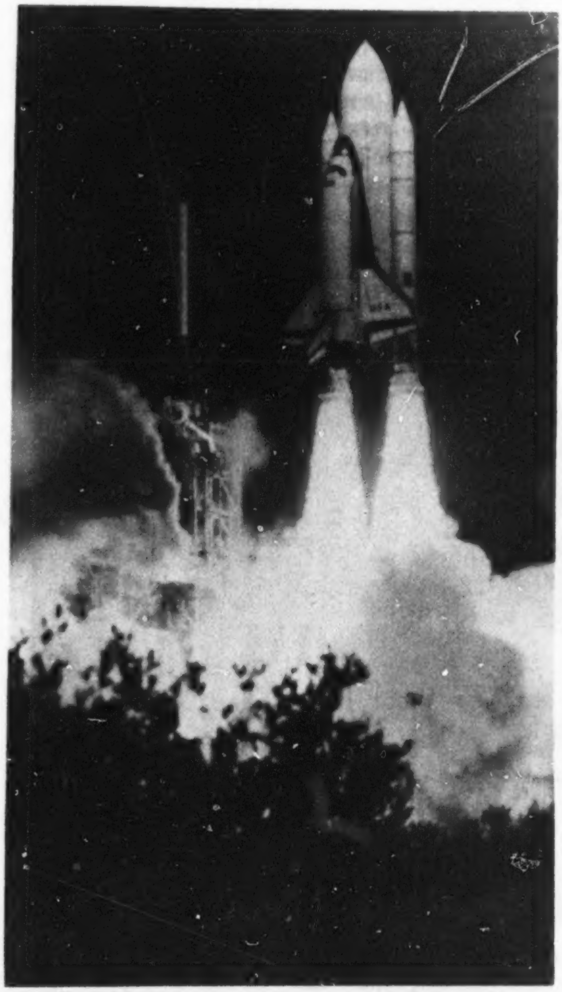
1981 was the year of the Shuttle. Two successful missions were conducted, in April and November, as the flight testing of the Space Shuttle, a key element in NASA's Space Transportation System, reached its halfway mark.

Astronauts John Young and Robert Crippen flew the Orbiter Columbia during its historic 54½-hour initial mission. The second flight, STS-2, carrying the first payload and the remote manipulator arm was manned by astronauts Joe Engle and Richard Truly.

The new era in manned space flight began April 12 at 8:00 a.m. EST, when the Space Shuttle roared off the launch pad at the Kennedy Space Center, Fla. The two-million-kilogram (four-and-a-half-million-pound) revolutionary spacecraft was thrust into space by a combination of two solid rocket boosters and a trio of liquid fuel Space Shuttle main engines.

Young and Crippen, during their two days in orbit, carried out a wide ranging series of systems checks to prove the feasibility of the Space Shuttle system.

During the flight, television cameras detected minor damage to the thermal protection system (TPS) tiles located on the orbital maneuvering system pods. The damage was not deemed serious.



First launch of the Space Shuttle Columbia, April 12, 1981.

At 10:21 a.m. PST, on April 14, the Columbia landed safely on Rogers Dry Lake at Edwards Air Force Base, Calif. The first Space Shuttle mission was determined to be an unqualified success.

The Columbia was returned to the Kennedy Center in a less spectacular way—piggybacked atop its 747 carrier aircraft.

STS-2, launched Nov. 12 from Kennedy Space Center, was significant in that it was the first time a spacecraft had been reused. Columbia, piloted by astronauts Joe Engle and Richard Truly, carried a space applications payload and a remote manipulator arm. It landed at Edwards on Nov. 14.

Despite a shortened mission, caused by a failed fuel cell, STS-2 was a success. Over 90 percent of the test objectives were completed by Engle and Truly and data from the OSTA-1 experiment package delighted investigators.

The Remote Manipulator System worked well and the thermal protection system again proved itself effective during the fiery entry through the Earth's atmosphere.

An investigation into the fuel cell failure began shortly after the orbiter was ferried back to the Kennedy Center from NASA's Dryden Flight Research Facility at Edwards.

Technicians at NASA's Kennedy Space Center's Orbiter Processing Facility remove the faulty fuel cell that shortened the second space shuttle mission to 54½ hours.

Within two weeks after landing, work began on readying the Columbia for its third flight test scheduled for March 1982.

Meanwhile, construction continued on the second orbiter, Challenger, at Rockwell International's plant at Palmdale, Calif. The newest orbiter is to be delivered to the Kennedy Space Center in mid-1982.

As orbiter construction proceeded, main engine testing continued at full power level (109 percent of rated power level) and external tank production maintained a steady pace.

As the Space Shuttle began to prove itself, a new study began on an unmanned launch vehicle based on solid rocket booster technology. SRB-X would be capable of boosting a 29,490-kg (65,000-lb.) payload into low Earth orbit or 5,443 kg (12,000 lb.) in geosynchronous orbit.

Space Transportation Operations

The successful flights of the Space Shuttle Columbia conducted in April and November paved the way for targeting the first operational STS launch (STS-5) for November 1982. Two more test flights are planned for March and July 1982.

STS users conferences held after each of the year's test flights briefed users on the results of both flights and the impact of each on future Shuttle planning. A new manifest calls for operational flight rates to build to 24 annually by 1988. The breakdown by fiscal year: 1983, 5 flights; 1984, 10; 1985, 13; 1986, 17; and 1987, 21 for a total of 66 operational flights through fiscal year 1987.

Early in 1981, the Air Force announced that Shuttle launch and landing facilities at Vandenberg Air Force Base, Calif., will not be ready until October 1985, a slip of one year from the previous planned operational readiness date. First flight from those facilities is a Department of Defense mission scheduled for October 1985. Eight launches are planned from Vandenberg through September 1987.

Delivery of the second Shuttle orbiter, Challenger, is scheduled for June 1982 with its first flight planned for January 1983. The third orbiter, Discovery, is scheduled for its first flight in January 1984. Delivery of the fourth orbiter, Atlantis, could be delayed up to a year depending on the outcome of current budget processes.

Nineteen new astronauts completed training in August, bringing the total flight-status astronaut corps to 79, including eight women.

Highlights from 1981 for the Office of Space Transportation Operations include:

- In December the European Space Agency (ESA) delivered to the United States the Spacelab module and pallet scheduled to make the first Spacelab flight aboard Shuttle in September 1983.
- The STS-2 flight in November carried the first Shuttle science payload. Known as OSTA-1, it consisted of Earth resources experiments and the pallet on which it was mounted was the first use of ESA developed Spacelab hardware.
- Final integration of the OSS-1 payload with its Spacelab pallet was completed in December for installation aboard the orbiter in early 1982. The payload is scheduled to fly aboard the STS-3 mission in March 1982 and will study space plasma physics and astronomy.
- Companies that might be interested in bidding on a future contract to do all Shuttle turnaround processing for NASA were invited to watch, at the Kennedy Space Center, Fla., the complete cycle of preparation of the Shuttle for its third flight.
- NASA and the West German firm Messerschmitt-Boelkow-Blohm GmbH (MBB) signed a launch services agreement for the first flight of the Shuttle Pallet Satellite (SPAS-01) currently scheduled for STS-7 in April 1983.
- Tentative plans were formulated for a possible retrieval and repair of the Solar Maximum Mission on the STS-11 mission in December 1983.
- Vought Corp., aerospace subsidiary of LTV Corp., Dallas, won a contract to continue production and launching of the Scout launch vehicle. Nine Scout launches are planned during the duration of the contract which is in effect from Nov. 1, 1981, through Oct. 31, 1984.
- McDonnell Douglas Astronautics Co., Huntington Beach, Calif., received a contract to build and launch an estimated 13 Delta launch vehicles over a two-year period beginning Oct. 1, 1981.
- Eleven satellite launches were conducted using Atlas Centaur, Scout, Delta and Atlas launch vehicles.
- Twelve expendable launch vehicle flights are scheduled for 1982.

Space Tracking and Data Acquisition

The Office of Space Tracking and Data Acquisition provides the vital electronic link between Earth and space for NASA's flight programs, including the Space Shuttle.

Its job is to keep track of where spacecraft are in orbit, tell them what to do, get information from them and process that information into a meaningful form. It does this primarily through two worldwide networks—one for deep space missions operated by the Jet Propulsion Laboratory, Pasadena, Calif., and the other for Earth-orbiting missions operated by the Goddard Space Flight Center, Greenbelt, Md. A global communications system called NASCOM ties the networks and various control centers together.

During the year, the networks supported an average of 25 flight missions daily. NASA's annual operating budget for its tracking and data acquisition functions is more than $400 million.

Highlights for 1981 included support of the first two orbital flight tests of the Space Shuttle Columbia in April and November, and the historic Voyager 2 flyby of Saturn in August. Space Shuttle mission support, among other things, enabled the world to see spectacular live television pictures from the Columbia in orbit.

Because of gaps in coverage during early Space Shuttle flights, temporary stations, primarily for voice communications, have been established at Dakar, Senegal; Gaborone, Botswana; Mahe, Seychelles Islands in the Indian Ocean; and Yarragadee in Western Australia. These stations will not be needed when the Tracking and Data Relay Satellite System is in place.

Work on integration and testing of the first Tracking and Data Relay Satellite continued at the TRW Systems Group, Redondo Beach, Calif. It is now scheduled for launch from the Space Shuttle in January 1983.

When this two-satellite, geosynchronous orbit system is in full operation, with its single ground terminal at White Sands, N.M., it will be the primary tracking and data acquisition system for the Space Shuttle as well as low Earth-orbiting satellites, eventually replacing ground stations of the Spaceflight Tracking and Data Network. Two stations of that network—Rosman, N.C., and Quito, Ecuador—were shut down during the year.

Finally, because of reductions in NASA's operating budget and the modestly declining workload of the three-station Deep Space Network, the 26-m (85-ft.) tracking antennas at Goldstone, Calif.; Madrid, Spain; and Canberra, Australia, ceased operations on Dec. 1. The stations will continue to operate 64-m (210-ft.) and 34-m (112-ft.) deep space tracking antennas as in the past.

Aeronautics

As the U.S. agency primarily responsible for advancing aeronautical science and technology, NASA conducts the research to maintain U.S. leadership in the world air transport market and preeminence in military aeronautics. The main NASA aeronautics centers are: Ames Research Center, Mountain View, Calif.; Langley Research Center, Hampton, Va; and Lewis Research Center, Cleveland.

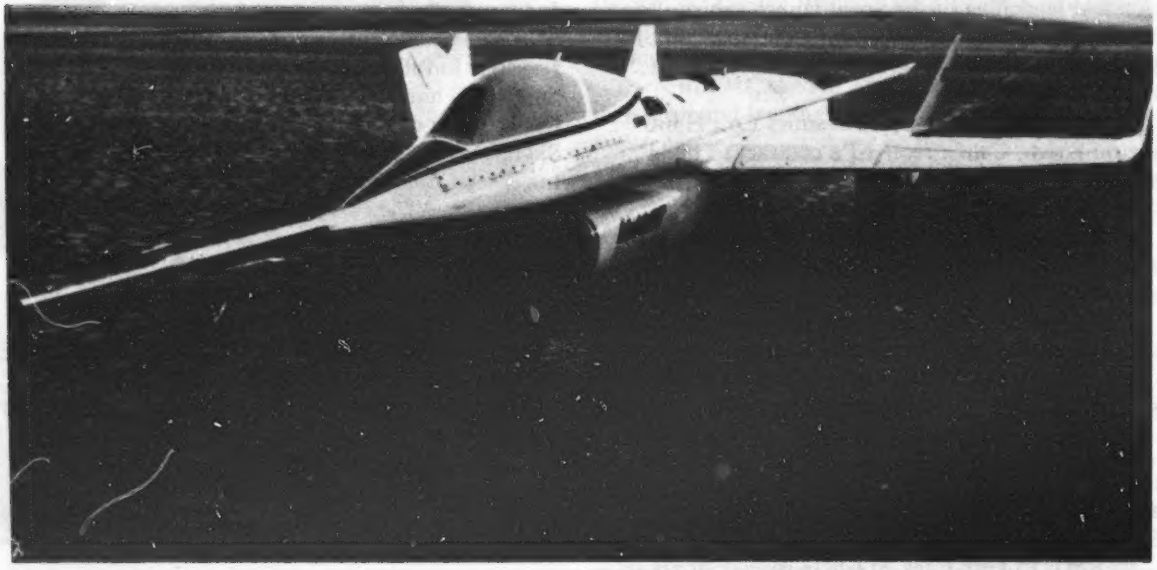
In 1981, NASA continued development of advanced technologies that could reduce fuel consumption in future commercial transport aircraft by as much as 50 percent. Elements of the research effort included turbine-driven fan jets and advanced turbine-driven propellers, computerized flight control systems, stronger and lighter weight structures and materials, and more aerodynamically efficient configurations.

The Energy Efficient Engine program element highlighted these efforts in 1981. Performance goals were demonstrated with various engine components, with the technology developed providing fuel savings in advanced turbine-driven fan engines of up to 20 percent over today's most efficient engines.

Teamed with the Federal Aviation Administration and industry, NASA tested advanced technology to enhance safety and efficiency in the crowded airspace around airports and under adverse weather conditions. These continuing efforts include aircraft ice protection concepts, fire resistant materials, aircraft crash dynamics, anti-misting fuel, lightning research, and advanced technology flight management systems and flight procedures.

The NASA/Army tilt rotor research aircraft, a promising concept for future civil and military applications, completed the proof-of-concept flight research phase this year. The aircraft combines the vertical lift, hover and maneuverability advantages of the helicopter with the greater forward speed of the fixed-wing aircraft. It flew about twice as fast and twice as far as a helicopter on an equal amount of fuel, achieving a top speed of 557 kilometers (346 miles) per hour. Flight demonstrations of this concept are planned for potential military and civilian users.

Maneuverability of a high speed fighter aircraft is one of its most critical elements. NASA and the Air Force are demonstrating a number of advanced technologies in a single research aircraft called HiMAT – for Highly Maneuverable Aircraft Tech-



NASA's HIMAT (for Highly Maneuverable Aircraft Technology), a remotely piloted research vehicle that allows high-risk flight testing without risk to pilots.

nology— which could double the maneuverability of future U.S. fighters. This year the research aircraft has expanded its flight testing to high transonic speeds, achieving over 7 g's maneuver load factor.

NASA's swing-wing research aircraft completed its flight program, demonstrating aircraft handling qualities at subsonic speeds with its wing angled, fore and aft, up to 60 degrees to its fuselage. Aeronautical theory indicates that such an oblique wing aircraft could fly at low supersonic speeds using less fuel and with no sonic boom audible on the ground. The wing is returned to the conventional position for efficient, quiet, low speed flight and for takeoff and landing operations.

NASA's Quiet Short-Haul Research Aircraft, demonstrating advanced aeronautical technologies aimed at solutions to airport congestion and noise problems, completed a flight evaluation series this year. Government, military, airline and industry pilots flew the research aircraft to evaluate its propulsive-lift technology. The aircraft's engine exhaust is directed over the wing surfaces to substantially increase lift, permitting quiet takeoffs and landings from short runways of smaller, closer-to-city airports.

NASA intentionally guided a modified F-106B jet fighter through severe southwest thunderstorms this year to study how lightning affects aircraft in flight. This and other basic knowledge about lightning is important to help safeguard future aircraft against a lightning strike. These efforts are a part of NASA storm hazard research, which includes studies of air turbulence, wind shear and storm hazards correlation.

Safety, energy efficiency and utilization of general aviation and commuter aircraft were emphasized in NASA research and technology efforts this year.

Acceptance flight tests of an advanced concept in aircraft flight control, navigation and flight management were completed. The system uses modern digital electronics, shared displays and modular concepts to achieve fault tolerance and increased reliability at potentially low cost. This system is being demonstrated in a NASA Cessna 402B aircraft.

Winglets, small structures attached almost perpendicular to wingtip surfaces, were developed by NASA as a means to reduce fuel consumption by lessening the effect of drag-producing vortices, the swirls of air that form at the aircraft wingtips. Similar winglets were tested on an agricultural aircraft in an attempt to make these vortices aid agricultural aerial applications.

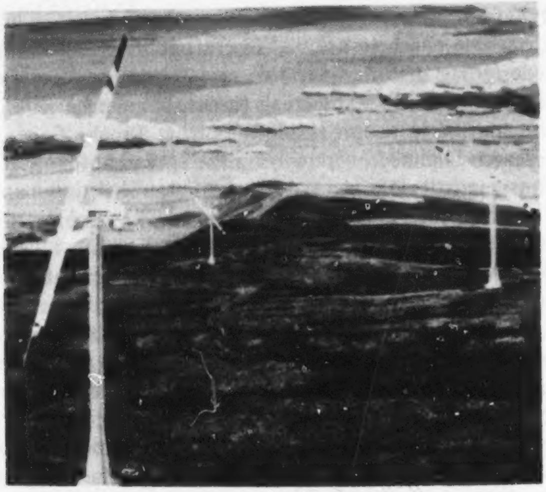
NASA and the FAA are studying the crash dynamics of light planes, including the energy-absorbing characteristics of aircraft subflooring. By redesigning the interior floor, researchers are attempting to reduce the crash forces that can be transmitted to people inside the plane. Other research is aimed at improving the energy-absorption characteristics of aircraft seats and restraint systems.

This research on crash dynamics is being expanded to jet transports and will complement current NASA/FAA research aimed at enhancing occupant survivability in post-crash fires.

In aerodynamics research, important strides were made in the use of high-speed computers to predict aircraft aerodynamic behavior. An algorithm was discovered that permits a 10-fold increase in computational speed and in calculating forces and flow velocities over aircraft wings and bodies. The method introduces a procedure permitting time steps in the computations that would normally produce instability and lack of convergence in the computation. The new procedure has been independently checked and is being adopted by researchers all over the world.

In propulsion, research on alternate hydrocarbon gas turbine fuels for aviation focused on fuel property characterization and combustor concepts for engines typical of commercial transport and commuter applications that minimize the impact of operating with poorer quality fuels that might be expected from oil shale or coal derived fuels in the future. Research results have shown that poorer quality fuels, lower in hydrogen content, result in significant increases in engine combustor liner temperatures and moderate increases in exhaust emission levels for current production combustor configurations. The advanced concepts, such as multistage combustion, have demonstrated a much lower sensitivity to fuel quality changes.

In aviation electronics, modern flight control system designs employing digital computers incorporate an independent backup computer system to preclude the simultaneous loss of all control channels. This approach increases the overall system complexity and cost. Recent research in controls has focused on the development of a technique of embedding backup software within the primary control system computers, thus eliminating the need for any additional hardware. Such software would be independently generated and called upon when a generic software anomaly occurred. Laboratory tests have demonstrated the effectiveness of this technique in reducing the cost and complexity of future digital flight control systems.



Artist's concept of the world's largest highest-capacity wind turbine installation, a three unit 7.5 million watt system located in Goodnoe Hills, Washington.

Energy Research and Development

NASA energy research, development and demonstration efforts, sponsored by the Department of Energy and other agencies, made significant contributions during the year toward advancing technologies to meet national energy needs.

A first generation, experimental, advanced gas turbine automobile engine was assembled to verify turbine aerodynamic efficiency advances and to continue development of ceramic components, the key technology needed to raise engine operating temperatures to engine efficiency goals.

Test of the first, intermediate temperature experimental Stirling engine demonstrated efficiencies equal to automotive diesel engines and emissions less than Environmental Protection Agency research goals.

First experimental ac electric vehicle propulsion system tests demonstrated an overall efficiency of 82 percent, equaling dc systems. With further development, both systems hold promise for improved performance and lower initial cost of an electric car.

Solar cell electric system technology advancements, this year, included improved methods for purifying silicon and for producing thin silicon sheets by ribbon crystal growth processes. Encapsulation system designs were developed and automation in assembly of cells into encapsulated modules was demonstrated. This process is consistent with program goals of providing technologies for cost-effective solar-cell electric systems in this decade.

Three large wind turbine electric generators began operation in 1981, bringing the total constructed to nine since program initiation in 1973. These latest machines are advanced designs installed at Goodnoe Hills, Wash., each providing 2.5 million watts to the power grid. Each of the three units in this first U.S. "wind farm" has 91-meter (300-foot) diameter blades. It is estimated that production versions of these machines could provide electric power for about 5 cents per kilowatt-hour, a price competitive with conventional power in many U.S. areas. Conceptual designs were completed on larger wind turbines that could produce power for about 3 cents per kilowatt-hour. These designs have rotor blades 122 m (400 ft.) in diameter and would produce 5 to 7 million watts.

Over 7,000 test hours have been accumulated on the first multi-kilowatt phosphoric acid fuel cell power plant being developed for on-site commercial/residential applications. An improved short cell stack configuration was tested for more than 5,000 hours at an operating pressure and temperature required for multi-megawatt utility applications. The latter configuration promises reduced overall system cost by at least 20 percent and an extended electrolyte inventory of 40,000 hours. An alternative air-cooled cell stack concept is also being investigated which holds the potential for system design simplicity and enchanced reliability.

New Key Personnel at NASA Headquarters

NASA Headquarters begins the new year with a host of new personnel in key positions: Comptroller, Deputy General Counsel for Policy Review, Associate Deputy Administrator, Associate Administrator for the Office of Space Transportation Systems, and Associate Administrator for Management.

C. Thomas Newman has been named NASA's **Comptroller**, replacing William E. Lilly who retired in October. Newman had been serving as acting Comptroller since Lilly's retirement. As Comptroller, Newman will direct and implement NASA's budget formulation and execution process and will provide the agency-wide financial control required to assure adequate, timely and essential accounting of all agency resources.

Robert F. Allnutt, NASA Associate Deputy Administrator since mid-1978, has been named **Deputy General Counsel for Policy Review**. In this position, he will be responsible for a series of reviews of the legal implications of major NASA policy areas.

Philip E. Culbertson replaced Allnutt as **Associate Deputy Administrator**. Culbertson will, as a special assignment, direct NASA planning for the development and operation of a U.S. Earth-orbiting platform or station capable of evolutionary growth to a facility which could support intermittent or long-term human habitation. Previously Culbertson had served as NASA's Assistant for Space Transportation Systems since 1979.

Major General James A. Abrahamson has been named **Associate Administrator for NASA's Office of Space Transportation Systems** where he will head Space Shuttle development. He is on assignment from the Air Force where he serves as deputy chief of staff for systems, Headquarters Air Force Systems Command at Andrews Air Force Base, Md. Abrahamson succeeds John F. Yardley who left NASA in May 1981 to become president of McDonnell Douglas Astronautics Co., St. Louis, Mo.

Dr. Walter B. Olstad is NASA's new **Associate Administrator for Management**, replacing Edwin C. Kilgore who retired in October. Olstad had served as Deputy Associate Administrator for Aeronautics and Space Technology since 1979. In this new position, Olstad will provide managerial direction involving all functional management and administrative matters such as personnel, supply and equipment, facilities and computer support. He will also provide managerial advice and support to Program Associate Administrators, the Deputy Administrator and the Administrator. The Office of Management was created under the NASA reorganization plan which became effective in November. This new office will handle part of the functions previously performed by the Office of Management Operations and some of the functions under the NASA Comptroller.

Third Shuttle Crew Selected

Jack R. Lousma and Charles G. Fullerton have been selected by NASA as commander and pilot, respectively, for the third flight of the Space Shuttle, Columbia. Backup crew will be Thomas K. Mattingly II, and Henry W. Hartsfield, Jr.

Lousma, a U.S. Marine Corps colonel, is a veteran of Skylab 3, July-September 1973. As mission pilot, he logged over 1,427 hours in space during which he and his fellow crewmembers accomplished 150 percent of preassigned goals.

Fullerton, an Air Force colonel, was assigned as pilot of the Space Shuttle *Enterprise* on the first, third and fifth flights in the Approach and Landing Test Series in 1977, when the vehicle was separated from the back of its 747 carrier aircraft and flown to a landing at Edwards Air Force Base, Calif.

STS-3 Crew in Simulator—Prime crew for the third flight of the Space Shuttle Columbia undergo training in the orbiter simulator at NASA's Johnson Space Center, Houston. Astronaut Jack R. Lousma (left) will be commander of the third Shuttle mission; astronaut Gordon Fullerton (right) will serve as pilot.

European Space Agency Delivers Spacelab For U.S. Shuttle

The major components of Spacelab—Europe's contribution to the NASA Space Transportation System—were shipped to the United States from West Germany aboard a U.S. Air Force transport the week of Dec. 6; the components arrived on Dec. 11 at NASA's Kennedy Space Center, Fla.

Spacelab is being developed and built under the aegis of the European Space Agency (ESA) by a European industrial consortium under the leadership of the West German firm ERNO Raumfahrttechnik GMBH. It consists of a habitable module and several unpressurized experiment support structures called "pallets." When placed inside the cargo bay of the Shuttle orbiter, Spacelab components will convert the Shuttle into a versatile on-orbit, scientific research center for both astronauts and civilian scientists.

The module and one pallet that will be used for the first Spacelab flight, which will be a joint U.S./European mission in September 1983, were among the components shipped to Kennedy.

The laboratory was formally delivered to NASA at a ceremony on Dec. 4 at the ERNO facilities in Bremen, West Germany. It was then transported overland to Hanover where it was readied for flight to the United States aboard an Air Force C5 Galaxy.

NASA's Marshall Space Flight Center, Huntsville, Ala., has prime NASA responsibility for Spacelab's procurement and operation and will manage its first three scientific missions. The laboratory will be prepared for flight and installed on the Space Shuttle at Kennedy Space Center. The Marshall Center is also responsible for developing and providing some additional associated components and computer software. NASA is purchasing a second flight unit for approximately $300 million. Delivery of the second Spacelab is due to be completed by 1984.

Acceptance and delivery of Spacelab marks a major milestone in a historic program of European-American space cooperation. Under ESA's nearly $1 billion Spacelab development program, which began in 1973, the 10 participating European states are supplying an engineering model and flight version of the laboratory, associated ground support equipment and some computer software—all at no cost to NASA. They will also provide 50 percent of the payload to be flown on the first mission.

Student-Developed Shuttle Experiments Receive Sponsors

Three student-developed experiments have received private-sector sponsorship to fly aboard an early Shuttle flight. Two of the projects received sponsorship as Get Away Special payloads; the other is designed to be flown in the orbiter mid-deck locker.

Get Away Specials are small self-contained payloads that will be flown in the cargo bay of the orbiter on a space available basis on operational flights. They are privately funded, small scientific research and development projects provided by a wide variety of users. They are limited to 200 pounds, cannot occupy over five cubic feet of space and do not require any special servicing. To date NASA has accepted 321 Get Away Specials to be flown on a space-available basis with major scheduled payloads beginning with the fifth Space Shuttle flight in 1982.

RCA Corp., Cherry Hill, N.J. has agreed to sponsor a student experiment as a Get Away Special. The project, to study the effects of weightlessness on a colony of carpenter ants, was presented to RCA engineers in October by students representing two high schools in Camden, N.J.—Camden and Woodrow Wilson.

Known as Orbit 81, the project is a cooperative effort between the high schools. It started in 1978 as part of an ongoing RCA objective to interest minority students in engineering careers.

The students chose a carpenter ant colony as the subject of their experiment because the insects have hard skeletons to withstand the rigors of launch and a social structure that might be affected by weightlessness. They plan to take photographs and movies of the colony while it experiences the gravity-free environment of space aboard the Shuttle. To control the temperature within the canister and operate cameras and their lighting, the students have programmed a microprocessor chip.

If students can meet their self-imposed timetable for constructing the ants' sealed container, it will be ready by mid-February.

The Asahi Shimbun, one of Japan's major daily newspapers also has recently signed an agreement with NASA to fly a Get Away Special. The experiment, suggested by two Japanese high school students, will use the near weightlessness of space to make artificial snow crystals directly from a gaseous substance while the Space Shuttle is in orbit.

Students from two New Jersey high schools examine a colony of carpenter ants as part of Orbit 81, a student-developed project designed to put ants into space aboard the Space Shuttle. Orbit 81 will test the effects of weightlessness on the colony. RCA Corp., Cherry Hill, N.J., will sponsor the experiment as a Get Away Special payload aboard an early Shuttle flight.

The experiment is expected to contribute significantly to crystallography, especially the crystal growth of semi-conductors or other materials from a vapor source. It will be the first to make artificial snow in a weightless environment. Historically, the first artificial snow-crystal experiments were made by a Japanese physicist, the late Dr. Ukichiro Nakaya, in 1936. Since then a variety of follow-on snow experiments have been carried out by Japanese scientists.

Honeywell Inc., Avionics Division, Minneapolis, Minn., has announced it will sponsor the space shuttle experiment of 17-year old Minnesotan, Todd Nelson, one of 10 winners in the first (1981) student science project competition sponsored jointly by NASA and the National Science Teachers Association.

Todd's experiment deals with aerodynamics in zero gravity; that subject is of interest to Honeywell because they are a major supplier of avionics systems for commercial, military and space applications.

Todd is a senior at Southland High School in Elkton, Minn. The experiment he wrote proposes high speed photography of flying insects in zero gravity to determine what orientation and flight problems are encountered and how the insects adapt aerodynamically to solve those problems.

For the experiment, a collapsible container stowed in the mid-deck locker of the Shuttle would carry a number of flying insects into space. During flight the astronauts would open the locker, expand the container, observe and photograph the insects flying in zero gravity. Those observations and films would be analyzed on Earth. The information gained from this and future experiments will help scientists in the design and construction of space colonies and apparatus used by space colonists for work, travel and recreation.

Honeywell has assigned two engineers to assist Todd; they will help him take the experiment from design to fabrication, to on-earth control experimentation and finally onboard a future flight of the Shuttle.

NASA Observatory Re-enters Atmosphere

HEAO-3, NASA's third and last in a series of High Energy Astronomy Observatories launched into space in the late 1970s, fell from orbit December 7 and burned up harmlessly in the atmosphere, according to NASA's Marshall Space Flight Center, Huntsville, Ala., which managed the HEAO series.

The first observatory, HEAO-1, re-entered the Earth's atmosphere and was destroyed in 1979. HEAO-2, nicknamed the "Einstein Observatory," is still in orbit but no longer operational. It is expected to re-enter the atmosphere and burn up by spring of 1982.

Launched in September 1979, HEAO-3 was designed to scan the heavens to further knowledge about cosmic and gamma rays, the two highest energy radiations in the universe. Although the observatory was designed for a mission life of six months, it continued to provide data until June 1981. At that time, HEAO-3 had expended the last of its thruster gases used for attitude control, and the observatory was powered down.

The mission of HEAO-3 differed from its predecessors, HEAO-1 and -2, which were designed to study X-rays. The information gathered by HEAO-3 about cosmic and gamma rays has extended the scientific world's knowledge about these mysterious radiations from deep space.

Through the study of cosmic rays, which are the nuclei of any given element and the highest energy particles known, HEAO-3 measured the relative abundance of elements in the cosmos. The observatory found unexpected differences between these amounts and the relative abundance of elements in the solar system.

Gamma rays, higher on the energy spectrum than X-rays, are emitted from galactic sources which may be unobservable to visible light telescopes. Gamma ray studies from HEAO-3 shed further knowledge about such astronomical question marks as black holes, pulsars, quasars, and supernovas.

"Flying Research Facility" Inaugurated as New NASA Research Tool

A "flying research facility," designed specifically to study advanced helicopter rotor systems under actual flight conditions, was recently inaugurated at NASA's Ames Research Center, Mountain View, Calif. The Rotor Systems Research Aircraft (RSRA), on its first NASA-piloted flight test, flew over San Francisco Bay at speeds up to 120 knots (138 miles per hour) for 45 minutes.

On its maiden research flight, the helicopter-type aircraft also was equipped with fixed wings and jet engines which will provide a portion of the needed lift for the study of helicopter rotors too small to support the research aircraft alone.

For the initial test phase, the rotor is the same type used on presidential helicopters—providing a highly reliable rotor for these first flights. Ames' Warren Hall piloted this first flight for NASA. The co-pilot was Lt. Col. Bob Merrill, deputy director of the U.S. Army flight test activity at Edwards Air Force Base, Calif. A second RSRA aircraft has been flown at Ames in the basic helicopter configuration.

The two RSRA aircraft, funded by NASA and the U.S. Army, are located at Ames to provide a national facility for in-flight investigation and verification of new helicopter rotor system concepts and technology. They can be flown as a helicopter or can be equipped with the fixed wings and auxiliary jet engines to enhance the vehicles' test capability.

Research programs will be aimed at increasing rotor aircraft speed, performance, reliability and safety, as well as reducing helicopter noise, vibration and maintenance.

In the current helicopter configuration, the RSRA utilizes a Sikorsky S-61 rotor and a drive system consisting of two T-58-GE-5 turboshaft engines, the main transmission, the 19-meter (62-foot) diameter main rotor, tail takeoff drive shaft, intermediate gear box, tail gear box and the 3.35-m (11-ft.) diameter tail rotor. The horizontal stabilizer is a "T"-tail with a 4.04-m (13.25-ft.) span.

In the compound configuration, a wing and two auxiliary jet engines are added and the tail is modified with the addition of a 6.86-m (22.5-ft.) span stabilator (stabilizer-elevator) and a rudder and associated controls. The wing has a 13.7-m (45-ft.) span and includes both aileron and flap surfaces. The two auxiliary jet engines are TF-34-GE-400A high-bypass-ratio turbofans with maximum rated static thrust of 4,207 kilograms (9,275 pounds) each.

The two RSRA aircraft were originally built by Sikorsky Aircraft Division of United Technologies Corp. for NASA's Langley Research Center, Hampton, Va., and the U.S. Army Research and Technology Laboratories with headquarters at Moffett Field, Calif. The two aircraft were transferred to Ames Research Center in 1979 for the joint flight research program by Ames and the Army.

Rotor Systems Research Aircraft in flight at NASA's Ames Research Center, Mountain View, Calif. The RSRA is a research aircraft funded by NASA and the Army that is both a helicopter and a fixed wing flying test bed. Two of these aircraft have been built for the government by Sikorsky Aircraft Division of United Technologies Corporation.

NASA Headquarters Reorganizes

NASA Headquarters underwent a structural and line-of-command reorganization in November. Changes included the combination of the Office of Space Science and the Office of Space and Terrestrial Applications into a new Office of Space Science and Applications and the establishment of an Office of Management which will handle a part of the functions now performed by the Office of Management Operations and some of the functions presently under the NASA Comptroller. The Office of Management will support the program offices in the management of research and development and institutional resources.

Under the reorganization, program office Associate Administrators will be the major line officers of NASA and the NASA Center Directors will report to Headquarters through these individuals as follows:

Jet Propulsion Laboratory, Pasadena, Calif., and Goddard Space Flight Center, Greenbelt, Md., will report to the Associate Administrator for Space Science and Applications;

Ames Research Center, Mountain View, Calif., Langley Research Center, Hampton, Va., and Lewis Research Center, Cleveland, will report to the Associate Administrator for Aeronautics and Space Technology; and

Johnson Space Center, Houston, Kennedy Space Center, Fla., Marshall Space Flight Center, Huntsville, Ala., and the National Space Technology Laboratories, Bay St. Louis, Miss., will report to the Associate Administrator for Space Transportation Systems.

NASA Administrator James M. Beggs said of the reorganization: "The specific goals of the new organization are to assure the proper delegation of authority to all line managers, set forth a clear distinction between line and staff and a simplification and clarification of field centers' reporting lines."

"Convertible" Engine May Offer Combined Helicopter-Aircraft Features

A revolutionary engine concept that could enable aircraft to maneuver like helicopters but attain cruising speeds of fast air transports using its helicopter rotor blades as fixed wings, is being studied by the Defense Advanced Research Projects Agency and NASA.

Essential to the new concept would be development of a convertible engine allowing the plane's turbofan engines to convert from the conventional, forward-thrusting mode to a mode that imparts torque to the shaft that drives the plane's horizontal rotor blades and back again.

The engine is "convertible" in the sense that it can operate as a turbofan engine by disengaging the rotor, as a turboshaft engine driving the rotor in the helicopter mode, or in both modes simultaneously. A sophisticated digital electronic system would be used to control the vehicle throughout all modes of operation.

In operation, the projected craft would take off vertically through the use of a lifting rotor. When it achieved desired altitude and forward speed, the engine would convert from powering the rotor to a forward thrust, turbofan, mode. The transmission would be disengaged and the rotor blade locked into a fixed position, their airfoil configuration imparting conventional lift to the plane for forward, level flight. Conversion from shaft power to forward thrust would take about 15 to 20 seconds.

NASA's Lewis Research Center, Cleveland, indicates such a craft could be ready for experimental

Research Center

Familiar Pilot—Sen. Barry Goldwater, R-Ariz., recently flew the Tilt Rotor Research Aircraft at Bell Helicopter Textron's Flight Research Center in Arlington, Texas. The Tilt Rotor Research Aircraft, a joint NASA/Army/Bell project, is capable of taking off like a helicopter and flying like an airplane. During the 45-minute flight, Goldwater made numerous takeoffs and landings as well as transitions to and from the airplane mode. The senator was accompanied by Bell test pilot Dorman Cannon.

flight testing in the mid 1980s and recently awarded a contract to General Electric Co., Lynn, Mass., to proceed with the engine test program to provide the basic technology for future concepts.

The powerplant selected for the convertible engine ground-test program is General Electric's TF-34 turbofan engine, now operational on U.S. Air Force and Navy planes with nearly one million hours of flight time.

Aeronautics research is a focus of work done at several NASA facilities: Ames Research Center, Mountain View, Calif.; Dryden Flight Research Facility, Edwards, Calif.; Langley Research Center, Hampton, Va.; and Lewis.

Specific mission of the project is to provide a research tool, a specially modified turbofan engine, to determine feasibility of the convertible engine concept with an automated control system.

Such an aircraft concept would represent a significant technical advance over vertical takeoff and landing planes now in service and provide a potential major breakthrough in the building and operation of such vehicles.

Some exploratory research aircraft have utilized separate powerplants for vertical flight and forward flight, or propulsion systems that must be physically redirected for either vertical or level flight.

The convertible engine concept eliminates much of the extra weight and expense of installing two separate powerplants to handle vertical and horizontal flight functions. This concept consists of a normal turbofan engine in combination with a fan shaft to drive the rotor through a transmission system.

Under the $5.6-million contract awarded by Lewis, General Electric will design and fabricate a converted TF-34, and deliver the modified engine to Lewis for a year-long testing and evaluation program. The engine testing project is planned for completion by late 1984.

The project is funded jointly by NASA and the Defense Advanced Research Projects Agency (DARPA). DARPA is a part of the Department of Defense and provides advanced research for the nation's military services.

Spacelab 1 Payload Specialist Reassigned

The European Space Agency has announced that one of three European payload specialists who had been preparing for the first flight of the NASA/European Spacelab in 1983 has been reassigned to other duties.

Dr. Claude Nicollier of Switzerland was one of five scientists picked in 1978 to operate the experi-

White House Honorees—The astronaut crew of the second Space Shuttle mission, commander Joe Engle and pilot Dick Truly, were recent recipients of the NASA Distinguished Service Medal at ceremonies held in the oval office of the White House. They received this award on Dec. 7, 1981, a date that also marks the 40th anniversary of the bombing of Pearl Harbor. From left to right are: STS-2 pilot Richard Truly; Cody Truly; President Reagan; Mary Engle; STS-2 Commander Joe Engle; NASA Administrator James M. Beggs; NASA Deputy Administrator Hans Mark; and NASA's White House liaison, James Fanseen.

ment equipment aboard Spacelab 1. He and fellow Europeans Dr. Wubbo Ockels and Dr. Ulf Merbold, together with American scientists Dr. Michael Lampton and Dr. Byron Lichtenberg, began a one-year hiatus from this training in summer 1980 because of a delay in the launch date. During this pause, Nicollier and Ockels underwent NASA astronaut mission specialist training at the Johnson Space Center in Houston.

While Spacelab training has resumed, the European Space Agency announced that it would leave Nicollier at Johnson to continue his training as mission specialist with a view to obtaining full capacity in this field for future Shuttle missions carrying European payloads. Ockels and Merbold will continue Spacelab training along with the two Americans. One American and one European will eventually be identified to fly. The other two payload specialists will operate ground-based equipment and support the pair on orbit.

Spacelab 1 is to be a joint American-European mission using the European-built Spacelab facility aboard a NASA Space Shuttle. The first three missions are being managed by NASA's Marshall Space Flight Center, Huntsville, Ala., which is responsible for payload specialist training.

Small Tail in Front May Make Light Planes Safer

Researchers at NASA's Langley Research Center, trying to enhance flight safety, are helping to make light planes inherently stall and spin-resistant.

Aircraft safety and efficiency is the focus of work at Langley and NASA's other leading aeronautical facilities—Ames Research Center, Mountain View, Calif.; Dryden Flight Research Facility, Edwards, Calif.; and Lewis Research Center, Cleveland.

During the past decade, more than 100,000 Americans were involved in more than 39,000 light plane accidents, according to a recent report by the National Transportation Safety Board. Nearly one in four of those accidents are believed to have been due to loss of control after the planes were either purposely or accidentally maneuvered into a stall or spin. One promising development in stall and spin prevention research is the rediscovery of the canard—a miniature wing that sprouts from the aircraft nose area.

The canard is the most recent focus of a NASA research program aimed at making light planes safer. Joe Chambers, assistant chief of Langley's Low-Speed Aerodynamics Division, strongly believes that " the aircraft tail-first, canard configuration is the shape of light planes for the 1990s."

The potential advantages of some of these far-out looking canard-configuration aircraft are very promising, both in terms of safety and efficiency. The canard was first proven effective by the Wright brothers at the turn of the century. Since then, it has been largely neglected due to early patent considerations and occasional flight handling problems.

The rebirth of the canard is being hastened by the booming market in homebuilt airplanes. Several designer-manufacturers are selling airplane kits to the public that include this forward, horizontal wing surface, in part because of fuel efficiency.

A demonstrated safety advantage, however, is what intrigued Langley researchers when they approached the designer of the VariEze, a novel-looking home-built airplane with canard, no horizontal tail, and a rear propeller engine. Constructed and flown by more than 400 kit builders in the United States, this two-seater (and others similar to it) have amassed an impressive stall-spin safety record.

A stall—loss of wing lift and, thereby, loss of aircraft control—generally occurs at low speeds and at certain flight altitudes, though stall can occur at any speed with gross and abrupt control inputs. A stall can cause a plane to veer sharply off course and out of control into a spin. Spins in some airplanes are unrecoverable.

Tests of a VariEze scale model in Langley's Spin Tunnel confirmed that, properly "loaded," the plane is virtually impossible to spin.

Its unique configuration, a combination of canard and narrow, swept main wing with vertical "winglets" at the wing tips, has a built-in resistance to aircraft stalling or spinning. Winglets, an invention of Langley's Dr. Richard Whitcomb, have already proven to be a fuel-efficient concept.

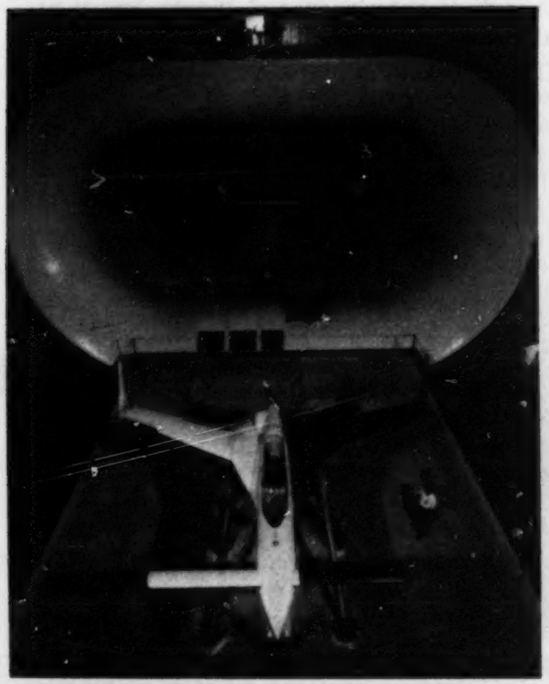
Another series of tests, however, revealed a problem already experienced by several VariEze owners under certain specific conditions that can result in a lateral stability problem. In "free-flight" tests in Langley's 9-by-18-meter (30-by-60-foot) Wind Tunnel, at low speeds and with the nose high, a model flew with a violent rolling oscillation, or wing rock. After study, researchers solved the problem with a simple modification of the main wing. Burt Rutan, the creator of the VariEze, immediately conducted a full-scale flight test with a modified wing, found it had indeed solved the problem and promptly recommended the change to all VariEze owners.

The last phase of wing tunnel testing planned for the VariEze has recently been completed in the wind tunnel. A full-scale VariEze, built in Langley's model shop, contributed detailed data about the complicated relationship of canard and wing placement, and their thickness and shape.

"We're also correlating this experimental wind tunnel work," Chambers says, "with computer codes to predict flight characteristics and hope, ultimately, to end up with a 'cookbook' for designers which can be used to quickly and easily design advanced configurations."

Another reason for the tests is to document the airplane's aerodynamic efficiency—which is considerable—without specifically trying to improve it. The airplane is exceptionally streamlined and lightweight, making use of foam sections covered with a seamless, lightweight composite material much like fiberglass. Advanced construction techniques is another area NASA will investigate in its light plane research.

The VariEze tests began more than two years ago when Langley research pilots Jim Patton and Phil Brown put the plane through its paces at the designer's facility in the Mojave Desert.



NASA's VariEze research aircraft undergoing wind tunnel testing at NASA's Langley Research Center, Hampton, Va.

One negative characteristic obvious to anyone who has flown the plane is that the canard is attached in a position that somewhat reduces pilot visibility during takeoff and landing. VariEze wind tunnel data, still being analyzed, is expected to determine whether the canard can be placed lower on the fuselage, more out of the pilot's sight, without sacrificing its excellent flight safety qualities.

NASA plans to continue tests with twin-engine versions of the VariEze configuration and other unusual canard designs, including possible canard application to larger aircraft such as commuters.

Spacelab 1 Crew Receive Training in Japan

Spacelab's six-member payload crew went to Japan in December to train to operate a group of instruments scheduled to fly on the first mission of the spaceborne research facility in 1983.

These instruments, used in an investigation called Space Experiments with Particle Accelerators are designed to help scientists gain an understanding of the Earth's magnetosphere and how it interacts with the upper atmosphere. The magnetosphere is an envelope of magnetic fields and charged particles that surrounds the planet. Principal investigator for the NASA-sponsored experiment package is Professor Tatsuzo Obayashi of the University of Tokyo.

The crew underwent several days of classroom training and practiced operating the actual flight experiment hardware which is installed in a vacuum chamber at Japan's National Space Development Agency on the outskirts of Tokyo.

The payload crew for the first Spacelab mission—a joint NASA/European Space Agency mission—consists of four civilian scientists called payload specialists and two NASA mission specialist astronauts. They are Drs. Byron Lichtenberg and Michael Lampton of the United States, Drs. Ulf Merbold of West Germany and Wubbo Ockels of the Netherlands, payload specialists; and Drs. Owen Garriott and Robert Parker, mission specialists. Two of the payload specialists will actually fly aboard the mission with the two mission specialists, and two will support the mission from the ground.

NASA's Marshall Space Flight Center, Huntsville, Ala., is responsible for managing the first three Spacelab missions.

Did You Know?

An exhibit of twenty-eight works of art documenting the development of the Space Shuttle project closed Jan. 4 after 10 weeks on display at the Smithsonian's National Air and Space Museum, Washington, D.C. The exhibition featured drawings, watercolors, gouaches, acrylics and oils, each artistically depicting various aspects of the Space Shuttle project from early tests in 1977 to the first launch of "Columbia" on April 12, 1981. Among the American artists and illustrators represented in the exhibition were Arthur Shilstone, Robert McCall, Charles Schmidt, Maria Epes and James Dean. The artists' impressions of this new era of manned space flight varied. Some chose to emphasize the technological complexity of the spacecraft while others were intrigued with capturing technicians at work on various stages of construction. The exhibition was prepared by the Museum in coordination with NASA. For more than 18 years, NASA has commissioned artists to render their impressions of key events in the United States space program. The works in the exhibition are only a portion of NASA's collection of Space Shuttle art.

National Space Technology Laboratories' Visitors Center recently reached two important milestones: its first anniversary and registering its 50,000th visitor since the Center opened Nov. 19, 1980. The figure represents an increase of more than 33,000 visitors over the previous year. Since its opening a year ago with expanded hours of operation, people from all 50 states and 56 foreign countries have registered at the Center. Among the visitors were Space Shuttle astronauts John Young and Robert Crippen who cut the ribbon May 8 to officially open the Center.

Idea Clearinghouse this month cites NASA's Jet Propulsion Laboratory, Pasadena, Calif., for using a conventional 35 mm microfilm system to transfer large quantities of technical documents to prospective contract bidders. JPL has found that reproduction and mailing costs can be substantially reduced if the procurement is large enough by using microfilm supported by a computerized listing of documents. Organizations contracting for hardware systems are often required to transfer large quantities of such documentation to prospective bidders for study. Each document is reduced according to its relative size so that blowback to hard copy is logically proportional. The particular document can then be easily located by referring to the computer printout which is organized by specific technical purpose. A typical arrangement might include a section for project control documents, design requirements, engineering drawing or parts lists. The bidders receive rolls of film and the computer printout. They can either view the film or reproduce the portions they select. The complete system is described in an article entitled "A 35 mm Microfilm System for Efficient Transfer of Information" by Leo R. Lunine, Microfilm Journal, Summer 1980. Questions concerning the system may be referred to Michael Fisher, JPL, FTS 792-6162.

Contractor News

TRW, Redondo Beach, Calif., has been selected to negotiate a $26.3 million dollar contract to develop, integrate, and install the Space Telescope Science Operations Ground System for NASA's Goddard Space Flight Center, Greenbelt, Md. The cost-plus-award-fee contract calls for an initial 4-year agreement with a 1-year option for software maintenance. The Science Operations Ground System consists of three functional elements, two of which will perform post observation data processing and science planning at the Space Telescope Science Institute, Johns Hopkins University, Baltimore. The other element, to be located at Goddard, performs instantaneous spacecraft instrumentation checks and observations scheduling. The award calls for TRW to provide the Institute complex astronomical data storage capability over the project lifetime.

From On High—STS-2 view of the Earth showing clouds over the Pacific Ocean with a full moon, taken from an altitude of approximately 161 statute miles.

McDonnell Douglas Astronautics Co., Huntington Beach, Calif. has been awarded a letter contract by NASA's Goddard Space Flight Center, Greenbelt, Md., to configure, check out and launch Delta space vehicles. This letter contract is expected to lead to a fixed-price incentive contract covering a two-year period starting Oct. 1, 1981. Estimated value of the letter contract is $26 million. Delta launch vehicles are used to place a variety of communications and scientific satellites in orbit. An estimated 13 launches are to be accomplished during the contract period.

International Business Machines Corp., Cape Canaveral, Fla., has won a three year renewal of an existing contract at NASA's Kennedy Space Center. The cost-plus-award-fee contract is for a value of $27,996,434, bringing the total value of the contract to $84,355,534 to date. Under the contract, IBM performs systems engineering and software development services in support of the Space Shuttle Launch Processing System at Kennedy and at Vandenberg Air Force Base in California. The term of the contract extension runs from October 1, 1981 through September 30, 1984.

Vought Corp., aerospace subsidiary of **LTV Corp.**, Dallas, has been awarded a contract for systems management of the Scout launch vehicle by NASA's Langley Research Center, Hampton, Va. The contract, valued at just over $39 million, is a three-year continuation of a similar contract awarded in 1976 and modified in 1979. The new contract begins Nov. 1, 1981. Under terms of the contract, Vought will provide all systems management, which includes systems engineering, reliability and quality assurance programs, vehicle processing and launch and logistics support services.

Modern Machine & Tool Co., Newport News, Va., has been selected by NASA's Langley Research Center, Hampton, Va., for negotiation leading to award of contract for force and strain measuring instrument support services. Typically, force and strain measurements are an integral part of wind tunnel and other testing. The cost-plus-fixed-fee contract, valued at approximately $3.2 million, includes the personnel, equipment, materials and facilities necessary to perform engineering design studies and the fabrication, calibration, installation, maintenance and repair of force-measuring transducers and related accessories. The three-year contract will be managed by Langley. The contractor will supply all personnel, materials and facilities to design, manufacture and structurally test the blades. In addition, the contractor will conduct a test of the blades in the Ames 40 by 80-foot wind tunnel and optionally conduct, in conjunction with government personnel, 30 hours of flight testing.

Boeing-Vertol Co., a division of **The Boeing Co.**, Ridley Park, Pa., has been selected by NASA's Ames Research Center, Mountain View, Calif., for final negotiations of a contract for the development of advanced technology rotor blades. Boeing-Vertol's estimated value of the six-year contract is approximately $13 million. The new rotor blades, which will be flown on the NASA/Army Tilt Rotor Research Aircraft, will provide increased performance and margins of safety and will demonstrate the use of advanced composite materials in this type of aircraft.

Lockheed Engineering and Management Services Co. Inc., Houston, has been selected by NASA for negotiations leading to award of a contract to manage and provide complete data processing support services for the Information Processing Facility at the Goddard Space Flight Center, Greenbelt, Md. The cost-plus-award-fee contract will be for an initial two-year period beginning March 1, 1982, with options totalling an additional three years. The contractor's proposed estimated cost for the initial two-year contract is approximately $38 million. The contract will call for Lockheed to furnish complete data processing support services including overall management of the facility; the five functional centers; equipment; systems engineering; software; configuration management; maintenance; test and calibration of equipment; operation of the systems; documentation; facility administration; and compliance with center security, safety and health regulations.

Boeing Aerospace Co., Seattle, has been selected by NASA's Marshall Space Flight Center, Huntsville, Ala., for negotiation of a $250,000 1-year contract to study the concept of an unmanned launch vehicle, developed from recoverable Space Shuttle components. The unmanned vehicle, called the SRB-X, referring in part to the initials of the Space Shuttle's recoverable Solid Rocket Boosters, would augment the Space Shuttle missions. A recent "request for proposal," issued by the Marshall Center, had invited interested firms to describe how they would accomplish preliminary definition of unmanned launch vehicles that would use Solid Rocket Boosters and motors as principal components. The study will be divided into two six-month periods—the first in which Boeing will analyze various configurations that the unmanned vehicle might take, and the second in which Boeing will be required to define in greater detail those particular options that seem most promising. NASA has assigned management responsibility of the SRB-X study to Marshall.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
Columbia (OV-102)	March	KSC	OSS-1
Columbia (OV-102)	July	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-B, Telesat-E, OSTA-2

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-D.	February 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Westar-IV	February 18	Delta	ESMC	Western Union communications. Reimbursable.
Insat 1A	April 8	Delta	ESMC	India communications. Reimbursable.
Intelsat V-E	May	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
NOAA-E/SAR	June	Atlas-73E	WSMC	NOAA/SAR weather. Reimbursable.
Navy 21	June	Scout	WSMC	DOD transit. Reimbursable. Callup.
Landsat-D	July	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August	Delta	ESMC	Canada communications. Reimbursable.
Westar-V	September	Delta	ESMC	Western Union communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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*Successful launch

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

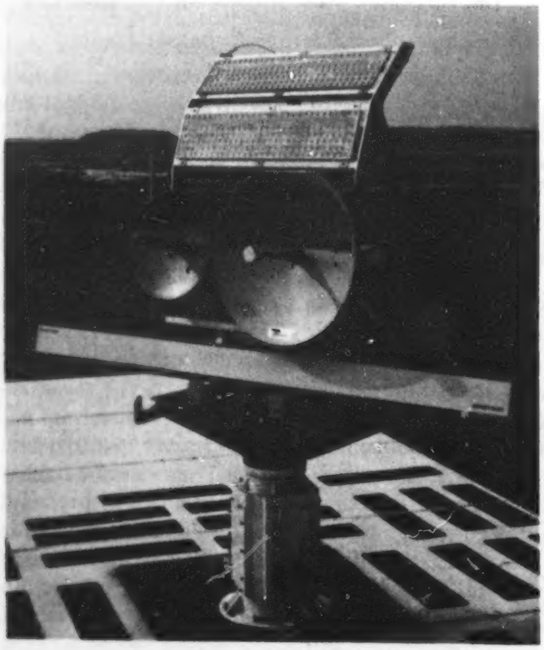
Inventor(s) & Employer	Title	Patent No.	Installation
Peter C. Wood, E. Vernon Ballou, and Prof. Leroy A. Spitze, San Jose State University Foundation, Calif.	Use of glow discharge in fluidized beds	4,303,961	ARC
James R. Currie, NASA/MSFC	Solar energy control system	4,304,219	MSFC
Reid A. Hull, NASA/LaRC	Moving body arresting line	4,304,320	LaRC
Anthony S. Girala, NASA/JSC	Open ended tubing cutters	4,305,205	JSC
William D. Kray, Talladega College, Talladega, Ala., and Robert W. Rosser, NASA/Ames	Synthesis of multifunction triaryltrifluoroethanes	4,307,024	ARC
Harold J. Walker, NASA/DFRC	Annular wing	4,307,856	DFRC
Ralph V. Sawyer and Bill Szuwalski, NASA/DFRC	Computer circuit card puller	4,307,510	DFRC
Howard E. Goldstein, Carlos Estrella, Marnell Smith and David A. Stewart, NASA/Ames and Daniel B. Leiser, Stanford University, Stanford, Calif.	Adjustable high emittance gap filler	4,308,309	ARC
Boris L. Seidel and Dan A. Bathker, Caltech/JPL	Antenna feed system for receiving circular polarization and transmitting polarization	4,308,541	NRO/JPL
Zenon Popinski, Caltech/JPL	Automotive absorption air conditioner utilizing solar and motor waste heat	4,307,575	NRO/JPL

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Automated Air Traffic Control

There are almost 200,000 general aviation aircraft operating into some 14,000 U.S. airports, mostly relatively small fields which do not have control towers. To enhance safety at high-traffic uncontrolled airports, NASA has developed in cooperation with the Federal Aviation Administration an experimental Automated Pilot Advisory System (APAS). The system provides pilots with airport, traffic and weather information in the vicinity of uncontrolled airports, and helps pilots to better meet the "see and be seen" requirement associated with visual flight rule operations. APAS has been successfully demonstrated at Manassas Municipal Airport, a busy general aviation field in northern Virginia.



The principal elements of APAS are radar (photo below left) for tracking approaching and departing aircraft, a computer system, weather sensors, and a transmitter for computer-generated voice reports to pilots. For the demonstrations, the APAS equipment was housed in a trailer containing an operator's control panel and instrumentation for checking the system's performance. An operational system concept would be untended and contained in a closet-sized package.

Radar and weather sensor information is fed into the computer system, which translates it into two types of voice advisories for pilots in the area. For advisory reception, user aircraft need no special equipment other than a standard VHF radio tuned to the proper frequency. Every 20 seconds, the computer-generated traffic advisory informs pilots how many aircraft are in the traffic pattern and where they are. Airport advisories broadcast every two minutes provide additional information: they identify the airport, indicate which runway is active, and relate wind speed, direction and other weather data.

In the Manassas demonstration, APAS achieved tracking accuracies approaching 100 percent; the system handled 250 to 300 aircraft a week and as many as 10 airplanes at one time.

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*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of such technology.

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Space Administration

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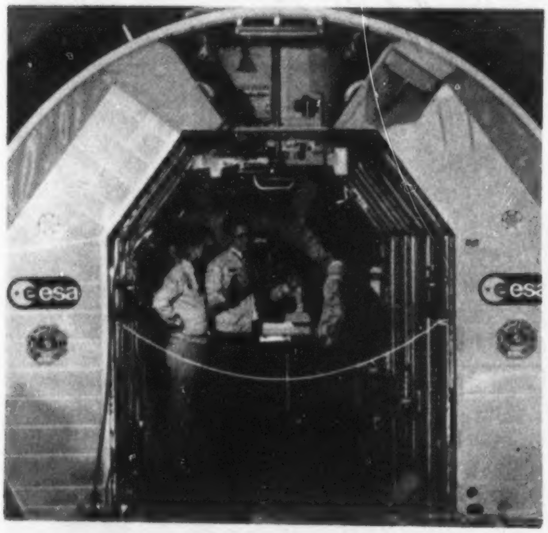
About the Cover

Vice President George Bush officiated at a Spacelab delivery ceremony held at NASA's Kennedy Space Center, Fla. on Feb. 5. The ceremony celebrated Kennedy's receipt of the first Spacelab flight hardware, the first manned hardware to be housed in the spaceport's Operations and Checkout Facility since the Apollo-Soyuz Test Project in 1975. Spacelab, a milestone in European-American space cooperation, is scheduled for a September 1983 Shuttle launch. Shown below, Bush is given a private tour of the Spacelab hardware following the ceremony.



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Letter from Washington

I welcome this opportunity to comment on President Reagan's proposed budget for NASA for Fiscal Year 1983.

This budget was prepared in the light of the President's two major policy priorities: reviving the economy and strengthening the national security. Inherent in those priorities are the principles of fiscal restraint and greater attention to NASA activities with national security implications.

Given the tightly constrained fiscal environment in which this budget was prepared, I believe we did well. This budget represents the Administration's commitment to the evolution of the Space Shuttle into an operational system. It also provides for continuing progress in major NASA program areas.

The President is requesting just over $6.6 billion for NASA for FY 1983. This represents an overall increase of $673 million, or 11 percent, over the revised plan for FY 1982. Factoring in inflation, we will have a slight increase in purchasing power throughout this fiscal year.

The $5.3 billion requested for research and development constitutes 81 percent, or the lion's share of the total request. More than half of this request, or $3.5 billion, is for Space Transportation, which includes not only the Shuttle, and its related systems—Spacelab and upper stages—but also our stable of expendable launch vehicles—the Scout, Centaur and Delta—as well.

The $3.5 billion would be divided about evenly between Shuttle production, system upgrading and performance augmentation on the one hand and Shuttle operations on the other. This is in contrast to previous years when funds for the latter lagged significantly below the former. The budget request reflects rapid movement into the operational phase, which we expect to begin in early Fiscal 1983 with the first operational flight.

The Shuttle's two orbital test flights were highly successful and proved that the concept of this extremely sophisticated, versatile and reusable space vehicle is technically sound. This budget is consistent with our immediate goal: to make the Shuttle the work horse of our civil and military efforts in space through the 1980s. The budget will support:

- A schedule of five planned launches including the first operational mission in FY 1983; 10 launches in FY 1984; and 13 launches in FY 1985;
- Continued progress in production of the third and fourth Shuttle orbiters, 103 and 104: (the second orbiter, 099, is scheduled for delivery during FY 1982);
- Provision of upper stages for planetary, geosynchronous and other special missions;
- Launch of the first Spacelab mission and continued procurement of the second Spacelab flight unit;
- Performance augmentation to reduce the weight of the solid rocket boosters and enhance the Shuttle's ascent performance for future NASA and national security missions;
- Preparation for a demonstration of the Shuttle's capability to retrieve an operational spacecraft—the Solar Maximum Satellite—for repair in orbit or return to Earth for refurbishment;
- The test, checkout and initial operation of the new Data Relay Satellite System (TDRSS).

In addition to increased emphasis on the Shuttle's operational capability, the FY 1983 budget will continue to support progress in aeronautical research and technology and in other vital areas of the space program.

Though some reductions have been made in the area of aeronautical research and technology, the FY 1983 request of $232 million will provide for technology advances in all aeronautical disciplines, stressing those which have been judged most vital in maintaining U.S. leadership in civil and military aviation. The budget preserves a strong research and technology base in aerodynamics, propulsion, materials and structures, aircraft controls and guidance, and human factors. It also maintains the experimental facilities and skilled personnel dedicated to this goal at the NASA research centers.

With Congressional approval, this budget will also support vital ongoing NASA programs. It proposes:

- $682 million for space science programs, emphasizing Spacelab missions; continued flight operations support anticipating Voyager's encounter with Uranus in 1986; developmental work on the Space Telescope, to be launched in 1985; on the Gamma Ray Observatory, to be launched in 1988; on the Galileo Jupiter

Probe, to be launched in 1985; on the support systems and science instruments of the International Solar Polar Mission, a joint NASA-European Space Agency program; and on the physics and astronomy explorers and suborbital activities.

- $320 million for important work in space applications missions, including the analysis of early data from Landsat-D's Thematic Mapper, a new generation Earth-scanning instrument which greatly improves our capability to study global resources; continued payload development projects for Spacelab, including materials processing; and analysis of early results from the International Search and Rescue Experiment, which will provide faster and more accurate data by satellite for locating aircraft or ships in distress.

The FY 1983 budget request also provides for continuing studies, investigations and definitions of mission options and advanced programs that will soon be possible because of the Shuttle's operational capability and flexibility. Possibilities under study include unmanned platforms in both low Earth orbit and geosynchronous orbit; a permanently manned facility, or space station, in low Earth orbit; and various elements of orbital test and transportation for their support.

I have given you brief highlights of our proposed budget for FY 1983. Like every other government agency we have had to reduce or delay some programs because of the urgent need to cut the rate of increase in Federal spending. But because of the importance to the nation of NASA's work and its spinoffs, we have come off well. And though there are no new starts, we are continuing with most of our ongoing activity in what we consider to be a balanced way.

Looking to the future, I am confident we will make the most of the opportunities the Shuttle affords as we open a magnificent new era of transportation, commerce and industrialization in space.

Note: Fiscal year 1983 budget figures for NASA were released on Feburary 6; the preceding text is the statement of NASA Administrator James M. Beggs regarding this budget and its impact on NASA programs.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

BUDGET PLAN	FY 1981	FY 1982	FY 1983
Research and development	4,334,338	4,738,000	5,334,000
Construction of facilities	116,950	98,700	100,000
Research and program management	1,071,064	1,144,700[a]	1,178,900
TOTAL BUDGET PLAN	5,522,352	5,981,400	6,612,900
OUTLAYS	5,425,557	5,831,000	6,582,000

[a] Includes increased requirement of $41.4 million to cover revised salary rates effective in FY 1982.

RESEARCH AND DEVELOPMENT PROGRAMS

BUDGET PLAN
(Thousands of Dollars)

Cognizant Office and Program	FY 1981	FY 1982	FY 1983
SPACE TRANSPORTATION SYSTEMS/OPERATIONS	2,728,600	3,090,100	3,467,800
Space Shuttle	1,995,000	2,163,000	1,718,000
Space flight operations	679,200	895,900	1,707,000
Expendable launch vehicles	54,400	31,200	42,800
SPACE SCIENCE AND APPLICATIONS	881,838	901,800	1,002,300
Physics and astronomy	323,700	323,500	471,700
Planetary exploration	175,600	205,000	154,600
Life sciences	42,188	39,500	55,700
Space applications	331,550	325,800	316,300
Technology utilization	8,800	8,000	4,000
AERONAUTICS AND SPACE TECHNOLOGY	384,000	344,000	355,000
Aeronautics research and technology	271,400	233,000	232,000
Space research and technology	110,700	111,000	123,000
Energy technology	1,900	---	---
SPACE TRACKING AND DATA SYSTEMS	339,900	402,100	508,900
TOTAL	4,334,338	4,738,000	5,334,000

RESEARCH AND PROGRAM MANAGEMENT

BUDGET PLAN
(Thousands of Dollars)

INSTALLATION	FY 1981	FY 1982	FY 1983
Johnson Space Center	176,051	186,635	192,396
Kennedy Space Center	150,200	163,441	169,500
Marshall Space Flight Center	164,985	170,840	177,704
National Space Technology Laboratories	5,506	6,086	6,252
Goddard Space Flight Center	162,448	170,066	173,638
Ames Research Center	94,843	102,689	104,893
Langley Research Center	120,776	127,951	131,303
Lewis Research Center	99,886	106,960	110,591
NASA Headquarters	96,369	110,032	112,623
TOTAL	1,071,064	1,144,700[a]	1,178,900

[a] Includes increased requirement of $41.4 million to cover revised salary rates effective in FY 1982.

TOTAL NUMBER OF PERMANENT POSITIONS - END OF YEAR

INSTALLATION	FY 1981	FY 1982	FY 1983
Johnson Space Center	3,380	3,346	3,293
Kennedy Space Center	2,155	2,133	2,112
Marshall Space Flight Center	3,385	3,351	3,285
National Space Technology Laboratories	105	104	104
Goddard Space Flight Center	3,699	3,661	3,623
Ames Research Center	2,058	2,037	2,021
Langley Research Center	2,895	2,866	2,845
Lewis Research Center	2,690	2,663	2,479
NASA Headquarters	1,506	1,491	1,457
TOTAL	21,873	21,652	21,219

1981 in Review—Part II

In the January edition of *NASA Activities*, summary reports of major achievements in agency program areas of Space Transportation System, Space Transportation Operations, Space Tracking and Data Acquisition, Aeronautics, and Energy Research and Development were presented. In this edition of *NASA Activities*, we will conclude our review of last year's accomplishments with the program synopses for Space Science and Applications, Space Research and Technology, and International Affairs.

Space Science and Applications

The exploration of the solar system continued with the successful encounter of Saturn in August by the Voyager 2 spacecraft. Building on the knowledge gained by the Voyager 1 encounter, the second Voyager provided information to resolve the ring structure in detail comparable to a street map. The rings now appear to consist of at least three discrete bands—the classical A, B, and C rings.

The incredible structure, which at one point caused Voyager imaging chief Dr. Bradford Smith to insist that there were not just thousands, but thousands and thousands of ringlets, is now undergoing reexamination. The various Saturn moons, sizable chunks of debris (the so-called shepherding satellites and others) and the enormous mass of Saturn itself are probably imprinting on the rings a harmonic wave-like feature representing gravitational influences among the various bodies. This theory has outlasted the debris-sweeping satellite theory, which was favored prior to the second encounter.

The thickness of the rings was deduced to be considerably less than the length of a football field. In human terms, this makes the rings the equivalent of a phonograph disk 40 km (25 mi.) in diameter—still one of the strangest objects in the solar system.

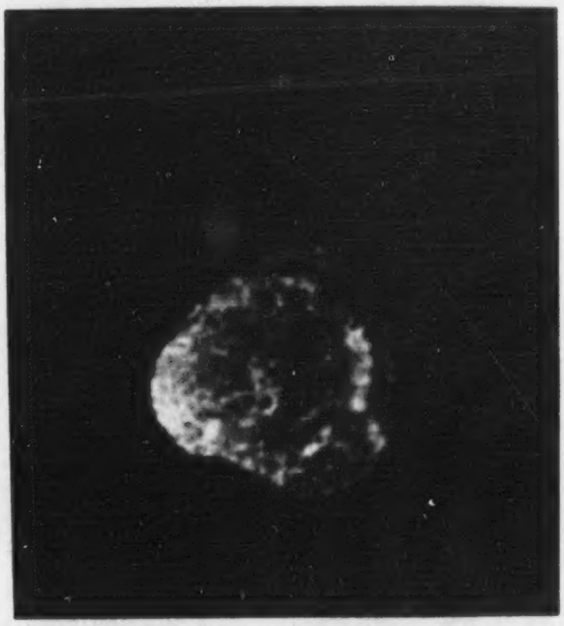
The atmosphere of Saturn was determined to operate dynamically different from Jupiter. There are no counter-cyclonic wind jets alternating within the cloud bands of Saturn; rather there is an equatorial jet stream of incredible speed—more than 1,770 km/hr (1,100 mph). This led atmospheric physicists to postulate that the dynamics of Saturn's weather are much more profoundly related to internal structure within the planet itself. A series of barrel-like atmospheric cells, each nesting inside another, was conjectured to represent the model of Saturn. Jupiter, by contrast, consists of a series of upwelling and downwelling zones separated by rapidly changing slipstreams creating a literal maelstrom of eddies.

The new Saturn class of moons, the mostly icy satellites, also were examined in increased detail and the surfaces of nearly all 17 moons mapped in detail. The extremely unusual moon, Hyperion, was photographed for the first time. This moon—perhaps a captured object—is orbiting Saturn in a manner which cannot be explained by conventional accretionary disk models. This moon has been described as being "Campbell soup-can shaped."

Voyager 2 is now on a trajectory which will intersect Uranus in January 1986. Scan platform problems encountered during the Saturn encounter are now mostly cleared and there is high confidence that the Uranus encounter will occur with no additional hitches.

Pioneer 6, 15 years after its launch, continues to return interplanetary and solar science information. This is the longest mission ever achieved for an interplanetary spacecraft. All Pioneers from 6 through 11 continue to function well.

The Pioneer 10 spacecraft achieved a milestone—it is now more than 25 thousand million miles from



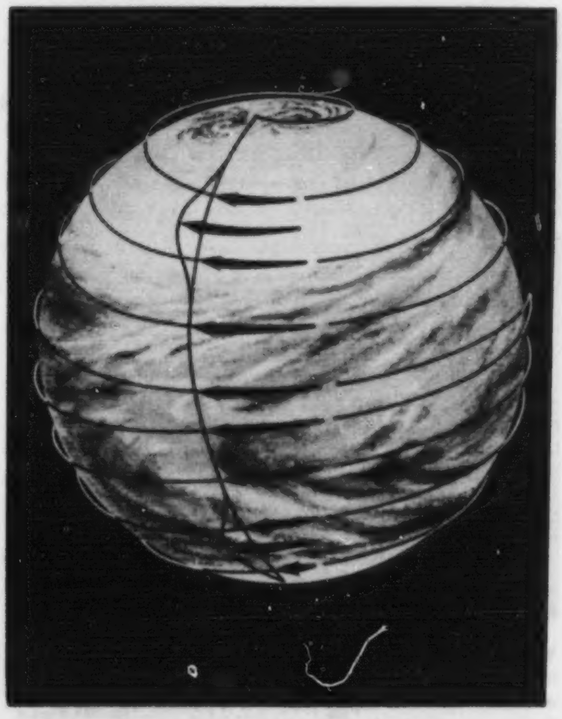
Voyager 2's view of Saturn's moon Hyperion—a moon never before photographed. The surface of Hyperion is pock-marked with many meteorite impact craters; it is possible that one of these impacts jostled Hyperion into its gravitationally unstable condition.

the Sun. Pioneers 10 and 11 are now providing first hand information about the nature and extent of the solar wind. This extended solar atmosphere gives way at some point, totally unknown, to the even more tenuous "atmosphere" of the Milky Way Galaxy. This limit, the heliopause, is the object of the extended Pioneer mission.

The Pioneer Venus mission continues to produce scientific results concerning the cloud-shrouded yellow neighbor of Earth. Long term studies now show that Venus has two different cloud states which alternate in dominance. The two patterns are a mid-latitude jet stream pattern which gives way over a period of several years to a cloud-and-wind pattern which behaves like a single air mass body.

The high altitude haze layer also has been shown to appear and disappear over periods of several years. Other Venus findings include the relationship of the tremendous Venus surface temperatures, 482 degrees Celsius (980 degrees Fahrenheit), to the long-term effects of a carbon dioxide atmosphere.

Scientists working for NASA discovered a natural carbon dioxide laser operating within the atmosphere of Mars. The power of the Red Planet's natural laser is about five times the power production of the United States. This natural laser provides another clue to the influences working within atmospheres to heat them. Past theory was held that a thermodynamic balance exists within the whole atmosphere.



Artist concept of the circulation patterns of Venus' jet streams which alternate in dominance over the yellow planet.

Researchers examining meteorites retrieved by NASA from the Antarctic have found miniscule diamonds within an iron-type sample. The diamonds are believed to have been formed in space during a great collision that probably took place in the asteroid belt many millions of years ago. Other NASA researchers theorized that the pressure and temperature of methane on Uranus might be conducive to the natural creation of diamonds on that green ringed planet. However, none of these diamonds has any commercial value due to their incredibly small size and the extreme difficulty of retrieving them.

The High Energy Astronomy Observatory program came to the end of its successful mission with the HEAO-2 spacecraft depleting all of its attitude control gas in June and the HEAO-3 depleting all of its control gas in August. These spacecraft, along with HEAO-1, were pioneering X-ray astronomy observatories and built a tremendous baseline of information about the X-ray universe. This work was preceded by the Uhuru satellite which had proved that X-ray astronomy could be performed. The HEAO-3 was a mapper while the HEAO-2 was a fine pointing observatory. Among their many discoveries was the possibility of a black hole at the X-ray source Cygnus X-1.

The Johns Hopkins University was named to be the location of the Space Telescope Institute. The Association of Universities for Research in Astronomy, selected to operate the Institute for NASA, has chosen Johns Hopkins as its partner in this venture. The Institute will operate as an observatory for scientists who use the Space Telescope, scheduled for launch aboard the Shuttle in 1985.

A new laser detecting and ranging device (LIDAR) was flown for the first time aboard a NASA aircraft. This new instrument uses light to sample atmospheric constituencies such as ozone and is intended for further testing aboard a Shuttle flight.

The Landsat-3 spacecraft's multispectral scanner was removed from operational service because of a malfunction. This leaves only the multispectral scanner from Landsat-2 to provide user information. The Landsat-3 television imaging system continues to operate.

The OSTA-1 payload successfully flew aboard the second Columbia flight in November. This payload, the first scientific payload to fly on the Space

Transportation System, carried a synthetic aperture, Earth-looking radar; an advanced infrared radiometer, an experiment to automatically map the plankton concentrations in the world's oceans; a test instrument to determine if Landsat-type spacecraft can be further automated; and a carbon monoxide mapper. Inside the cabin the crew operated a lightning detection device and monitored the performance of a plant growth experiment.

Except for the plant growth experiment, which failed due to the shortened flight time of STS-2, the rest of the experiments were judged successful by their investigators. The radar, in particular, was a spectacular success, showing Earth terrain features never before mapped from space. The entire payload was chosen to provide information and data to aid in designing a new generation of Earth resources orbiting satellites.

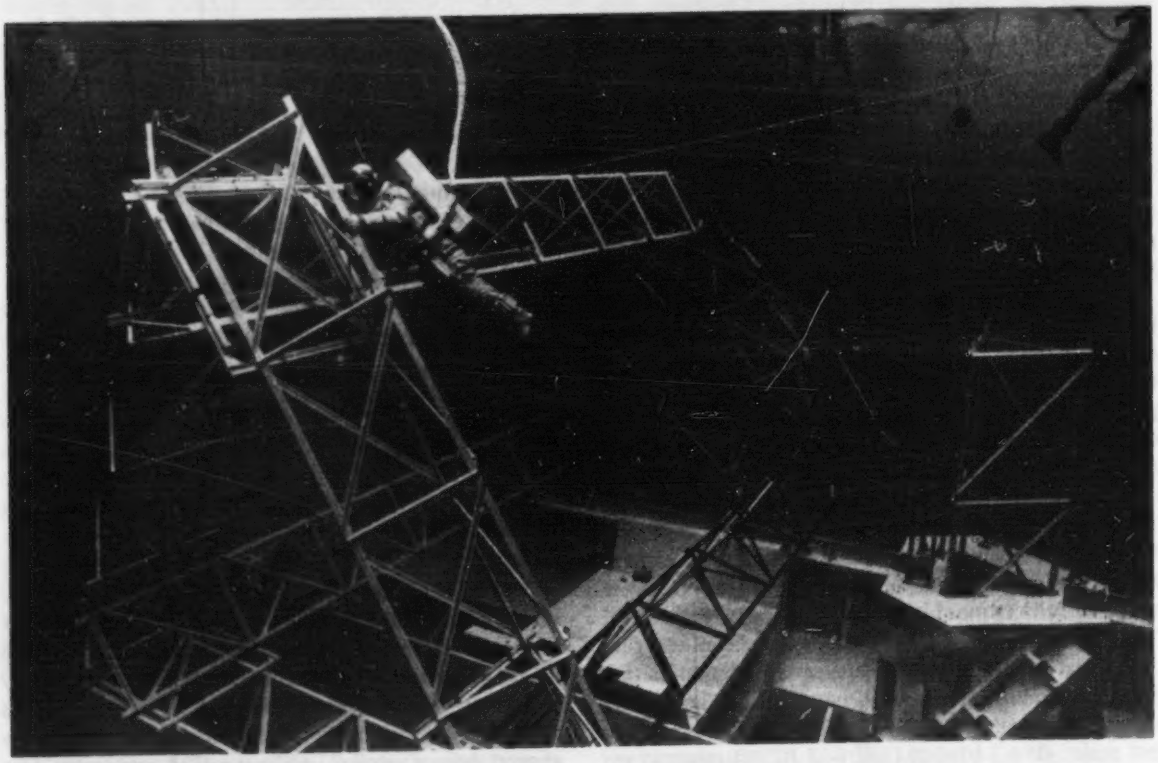
Space Research and Technology

NASA research and technology developments in 1981 continued to expand the U.S. technology reservoir supporting national space capabilities.

An image processor designed for robotic vision applications was successfully demonstrated at NASA's Jet Propulsion Laboratory, Pasadena, Calif., for the first time. Vision capability is the most valuable sensor for robotic control during automated satellite servicing and in-space structure assembly and construction. The image processor could visually track objects at a 15 video-frames-per-second rate. The laboratory demonstration is an early step toward control-oriented computer vision system development for space robotics.

A mobile work station concept from which space-suited astronauts could assemble large structures in space was developed and tested at NASA's Langley Research Center, Hampton, Va., and Marshall Space Flight Center, Huntsville, Ala., under simulated space conditions. The station is designed for operations attached to the Space Shuttle or as a free flyer. The astronauts would be attached by foot restraints to the station, freeing their hands for the assembly tasks.

Concepts were developed for assembly, without tools, of large structures in the weightless environment of space using lightweight composite columns and unique, specialized joints. Assembly of a



Mobile work station assembly concept being tested in the neutral buoyancy tank at NASA's Marshall Space Flight Center, Huntsville, Ala.

38-element structure in both a 1 g laboratory environment and in a neutral buoyancy tank simulating the weightlessness of space has shown the structural concepts to be practical.

An experimental computer program for automatically planning and scheduling spacecraft action sequences was designed and developed at the Jet Propulsion Laboratory. The program combines artificial intelligence technology with operations research and techniques to automatically perform tasks which typically require support from a number of mission operations specialists. The experimental computer program was successfully demonstrated on realistic Voyager-like spacecraft sequences spanning a six-hour operational period involving dozens of spacecraft actions and events.

The orbital flight tests of the U.S. Space Shuttle also began a unique flight research program supporting NASA's advanced (21st Century) space transportation program. Flight research experiments onboard measure orbiter performance, providing precise engineering data for the timely and evolutionary development of future space transportation concepts.

International Affairs

A milestone in European-American space cooperation occurred Dec. 4, 1981, when the European Space Agency Spacelab unit was accepted by NASA at a rollout ceremony in Bremen, West Germany. Spacelab is a major element in the NASA Space Transportation System with facilities and equipment similar to laboratories on Earth but adapted for zero gravity. The first Spacelab mission is currently scheduled for September 1983.

The second test flight of the Space Shuttle (STS-2) in November carried for the first time the Canadian-developed Remote Manipulator System (RMS) and the first European-developed Spacelab hardware, a pallet, into space. The Remote Manipulator System, or arm, is designed to place payloads into orbit and retrieve them, as well as for other freight-handling activities in space. Astronauts Joe Engle and Richard Truly operated the arm in all of its modes, ranging from fully automatic, in which it is programmed in advance by computer to perform a series of operations, to fully manual in which it is operated directly from a control panel that bypasses the computer.

The five OSTA-1 experiments on STS-2 that were flown in the orbiter's payload bay were carried on a special "U"-shaped structure called an orbital flight test pallet. The 3-by-4-m (10-by-13-ft.) aluminum frame and panel structure weighing 1,218 kg (2,685 lb.), is an element of Spacelab, a reusable, modular research facility being developed for the Space Transportation System by ESA in cooperation with NASA.

The Spacelab pallet carried on STS-2 was an engineering model of the flight version pallet. This engineering unit was certified for flight and was adapted for use with special subsystems which provide interfaces between the payload and orbiter systems. The subsystems were developed by NASA using, for the most part, off-the-shelf hardware.

The pallet, developed for ESA, is built by the British Aerospace Dynamics Group under subcontract to ERNO Raumfarttechnik GmbH, the prime contractor for ESA.

NASA and the West German firm Messerschmitt-Boelkow-Blohm GmbH (MBB) signed a launch services agreement in June for the first flight of the Shuttle Pallet Satellite (SPAS-01) which will be carried into orbit on the third Space Shuttle operational flight, STS-7, now scheduled for February 1983. It will be the first payload to be deployed and retrieved by the Canadian-built arm.

MBB's objective is to conduct materials processing research experiments while SPAS is in the Shuttle payload bay. After these experiments are finished, NASA will use the payload in a test of the Remote Manipulator System's deployment and retrieval capabilities during the five-day mission. A 70-mm camera mounted on SPAS will provide photo coverage during deployment, free flight, retrieval and reberthing on the Shuttle.

MBB is the fifth international user to sign a Shuttle launch service agreement with NASA, joining India, Indonesia, Telesat Canada and Intelsat. The agreements signed with India, Telesat Canada and Intelsat also provide for launches aboard NASA expendable launch vehicles—Delta or Atlas Centaur—prior to the Shuttle becoming operational. In addition, the Arab Satellite Communications Organization (Arabsat), Australia, Colombia, the Federal Republic of Germany, Italy, Japan and Luxembourg have reserved launches aboard the Shuttle or NASA expendable launch vehicles, and a number of other countries are expressing interest.

On May 23 and Nov. 15, 1981, NASA launched Intelsat V spacecraft aboard Atlas Centaur launch vehicles. The launch service agreement with Intelsat, which was signed in 1980, provides for launch and associated services for six Intelsat V spacecraft. The next two satellites in the series also will be launched aboard Atlas Centaurs, while the fifth and sixth satellites are scheduled to be launched from the

Spacelab engineering model pallet being installed aboard the Columbia for the Shuttle's second flight last November.

Space Shuttle. In addition, NASA and the Italian National Research Council (CNR) signed a Memorandum of Understanding in July 1981 that provides for a launch and associated services for the Italian Research Interim Stage (IRIS) payload on the Space Shuttle.

In 1980 NASA agreed to include two European scientists in the mission specialist astronaut training program in recognition of the substantial contribution ESA is making to the Space Transportation System by funding development of Spacelab. ESA is reimbursing NASA for the costs of this training. The two European scientists completed the first phase of their training at the Johnson Space Center in Houston during August 1981.

ESA decided in September, that one of the mission specialist trainees, Dr. Wubbo Ockels, would transfer to NASA's Marshall Space Flight Center in Huntsville, Ala., to resume payload specialist training in preparation for the first Spacelab flight. Dr. Claude Nicollier, the other trainee, will continue as an ESA astronaut at Johnson for possible selection as a mission specialist for flight on board the Shuttle with the planned German "D-1" Spacelab mission in 1985.

The Infrared Astronomical Satellite (IRAS), which is to carry out an all-sky survey of discrete infrared sources, is a cooperative project involving the United States, the Netherlands and the United Kingdom. The United States is producing the cryogenically-cooled infrared telescope system; the Netherlands is furnishing the satellite; and a mission control center will be established in the United Kingdom. Spacecraft testing of IRAS was completed in September 1981 in the Netherlands. The spacecraft was then shipped to the United States where it is going through its final development and test phase leading to a launch in August 1982.

The Active Magnetospheric Particle Tracer Explorer (AMPTE) mission will study the interaction between the solar wind and the Earth's magnetosphere through release of chemical tracer elements. AMPTE is a dual spacecraft mission with NASA providing the Charge Composition Explorer and West Germany, the Ion Release Module. NASA will launch the two spacecraft on the same Delta vehicle in 1984. The development phase of the project began in 1981. A Memorandum of Understanding between NASA and the Ministry for Research and Technology of the Federal Republic of Germany was signed Oct. 15, 1981, outlining the responsibilities for each side.

Development continued during 1981 on Galileo, a cooperative project with the Federal Republic of Germany which will continue the exploration of Jupiter and its environment. The Federal Republic of Germany is contributing a Retro Propulsion Module to inject the Galileo spacecraft into Jovian orbit, as well as other mission hardware. Critical design reviews of the mission hardware and systems requirements reviews have been completed. Several components are nearing completion and the development model for the probe's heat shield recently passed tests at NASA's Ames Research Center, Mountain View, Calif. Launch of the Galileo orbiter and atmospheric probe is now planned for 1985.

Development also continued on the Space Telescope, a cooperative project with the European Space Agency, which is scheduled for launch on the Space Shuttle in 1985.

Announcements of opportunities were issued worldwide for participation in further scientific analysis of data acquired in a variety of NASA missions ranging from Viking-Mars data and Apollo lunar samples to astrophysics observations from the High Energy Astronomy Observatories. As a result of previous such announcements, scientists were selected for definition studies of scientific instruments for possible flight on the Solar Optical Telescope, the Upper Atmospheric Research Satellite and the Origin of Plasma in the Earth's Neighborhood program.

During 1981, planning proceeded on the multilateral Search and Rescue (SARSAT) program. In addition to the United States, Canadian, French and Soviet participation previously agreed upon, Norway has been added as an investigator on the project.

NASA and the Indonesian National Institute of Aeronautics and Space signed a Memorandum of Understanding for the establishment of a Landsat ground station at Pekayon, near Jakarta, Indonesia.

Ten foreign Landsat ground stations are already in operation outside the United States: Prince Albert, Saskatchewan and Shoe Cove, Newfoundland, Canada; Cuiba, Brazil; Fucino, Italy; Kiruna, Sweden; Tokyo, Japan; Hyderabad, India; Alice Springs, Australia; Mar Chiquita, Argentina; and Harkbeesthoek, South Africa.

A ground station in Thailand is receiving test signals and a number of other ground stations are in the planning stages.

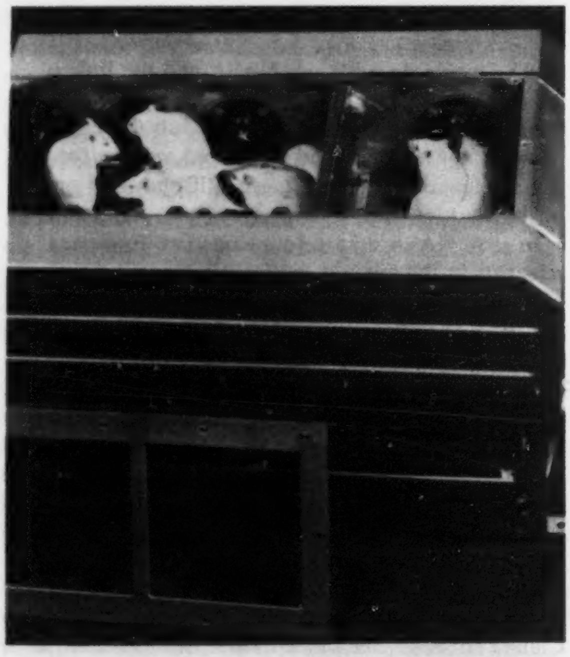
In 1981 NASA negotiated a 10-year renewal of the Interagency Agreement for the Operation of Tracking Facilities in Australia.

Agreements were also concluded for the establishment of a Shuttle Support Communications Facility in Gaborone, Botswana, and the upgrading of the Shuttle support facility in Dakar, Senegal.

NASA provided, through its Spacecraft Tracking and Data Network (STDN), reimbursable tracking support for ESA's Ariane launchings and the Meteosat II satellite.

Reimbursable tracking support was also provided to Japan for its Astro-A and GMS-II satellites.

Mutually beneficial cooperation between the United States and Soviet Union in the area of planetary research was developed further during 1980. In October, the U.S./U.S.S.R. Joint Working Group on Near-Earth Space, the Moon and Planets met in San Francisco to review the status of collaborative efforts in process, exchange information on future plans for lunar and planetary exploration and identify potential areas of mutual interest for future bilateral cooperation. Scientists from both countries exchanged the results of the U.S. Pioneer Venus and Soviet Venera 11 and 12 missions which



Rat mating chamber launched aboard Cosmos 1129 in Fall 1979 with two males and five females in separate compartments. The dark discs are feeding stations where a paste and water diet were dispensed.

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A letter agreement was concluded in May 1981 between NASA and the Italian National Research Council for an advanced development study of a Tethered Satellite System. The project involves a data-gathering satellite suspended from the Shuttle on a tether up to 97 km (60 mi.) long.

Should the Tethered Satellite System receive budgetary approval, the Italians will be responsible for the satellite and NASA for the tether and deployer mechanism, as well as for overall systems integration.

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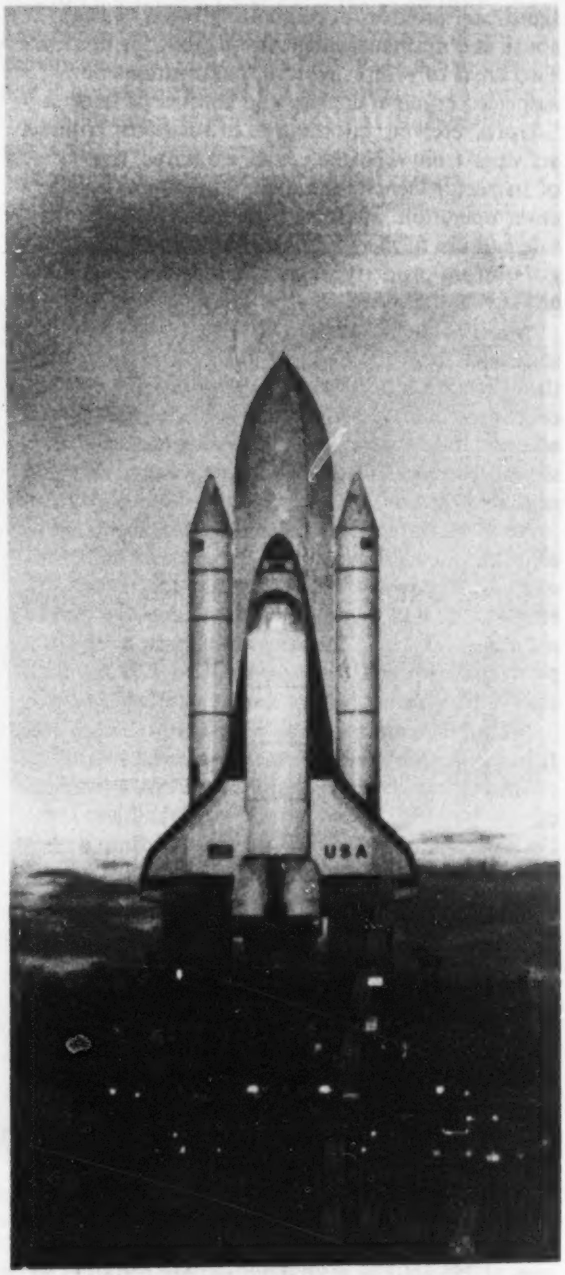
Development of the reusable space plasma physics experiments facility (SEPAC) in Japan is near completion at the end of 1981 and will be delivered to the United States in 1982 for integration for the Spacelab 1 mission.

Proposals were selected for participation in the Crustal Dynamics Program using space geodetic data for application to Earth movement measurements and earthquake modeling. Over 20 foreign investigators from Germany, France, the Netherlands, Canada, China, Chile, Peru, Venezuela, Spain, Switzerland, Australia and New Zealand were chosen. Negotiations continued with other countries including Italy, England and France for other cooperative geodynamics studies activities.



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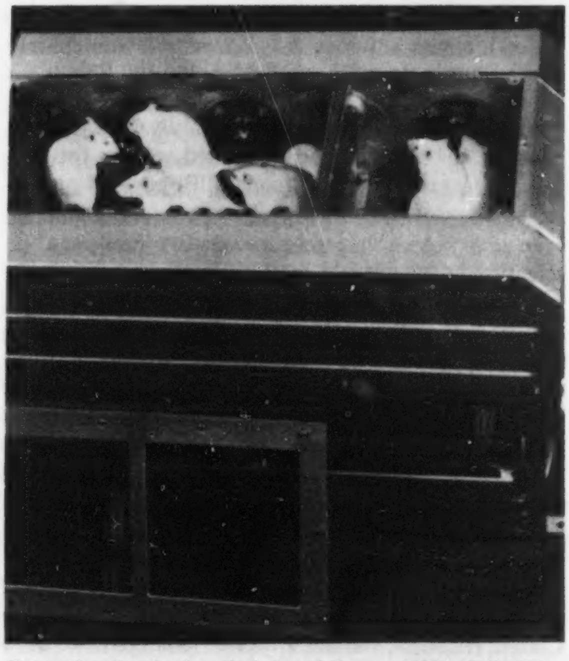

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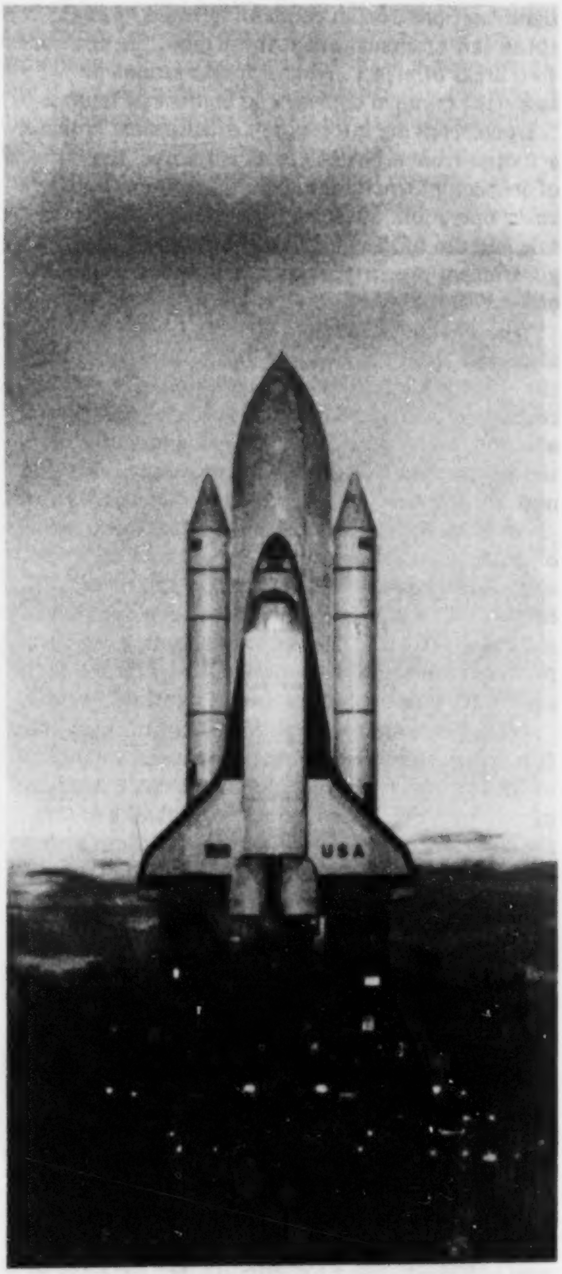

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Inspector General Activities

During the past several months, NASA's Office of the Inspector General (OIG), in cooperation with NASA management and employees, has made significant progress in combatting fraud, waste, abuse and mismanagement throughout the agency. Two areas of effort involved investigations of suspected criminal activity and conflict of interest.

Upon receiving information of suspected criminal activities from a NASA center employee, the Office of Inspector General initiated a three-month undercover operation. Suspected violations included the sale and use of illegal drugs, drunkenness, theft of government property, sexual harassment, gambling and dereliction of duties.

With the cooperation of NASA management and assistance from the FBI and local police department, the operation was concluded with the arrests of six contractor employees for the above cited charges. In addition, one contractor employee voluntarily resigned, two were suspended for three days each for neglect of duties and six received written reprimands.

An investigation was also conducted at the request of center management which led to the resignation of a NASA employee. The investigation revealed the employee in addition to his NASA center employment also served as an officer of a company that produced a material both developed by NASA and associated with his NASA employment.

Becuse the employee was directly involved in the firm's financial transactions, this created a conflict of interest which is a violation of NASA's standards of conduct. The investigation also established that the employee falsified his Statement of Employment and Financial Interests and failed to request approval of outside employment as required by NASA regulations.

Recommendations from the Office of the Inspector General resulted in NASA management requiring the employee to either divest himself of his outside business or to resign from NASA; the employee elected to resign.

NASA's Office of the Inspector General urges all employees to continue with such efforts in meeting the challenge of improving NASA programs. Suggestions for eliminating waste and mismanagement are welcome. Identities can be confidential. There is a 24-hour answering service in the Washington, D.C. area at 755-3402 or a toll-free number for all other areas at (800) 424-9183.

Written suggestions or complaints should be mailed to: NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, D.C. 20024.

Applications Technology Satellite Repositioned

NASA has begun relocation of the geosynchronous Applications Technology Satellite-1 (ATS-1) from its present position at 149 degrees west longitude to a new position about 50 degrees farther west to 162 degrees east longitude.

The present location at 149 west longitude requires maximum thruster use to maintain the orbit position. Relocating to 162 east longitude puts the satellite into a more stable position where the power from onboard thrusters required for station keeping is reduced substantially.

At its location of 149 degrees west, the satellite required twice weekly station keeping management. Estimates of onboard fuel supplies indicated the useful lifetime of the satellite would end sometime mid-1982. Several options concerning the extension of this lifetime have been examined by the Goddard Space Flight Center, Greenbelt, Md., including the present action to move the spacecraft to 162 degrees east longitude.

This action will prolong the orbital station keeping period of ATS-1 through 1983 and will reduce station keeping activities to quarterly from bi-weekly. This new position also improves the satellite's "look angle" to more westerly islands in the Pacific Basin.

The ATS-1 satellite is the oldest synchronous communications satellite still in use. Present experiments include voice transmissions among 11 Pacific island nations, the Trust Territory of the Pacific, Australia, New Zealand, Hawaii and California. Other experiments provide medical care delivery communications for Alaska, technology transmissions between Japan and Australia, and coordination of oceanic research vessels in the Pacific and Gulf regions.

The ATS-1 was launched on Dec. 7, 1966, and has been a pioneer in the use of communications satellites for health care delivery, education, public safety, emergency communications and mobile land and maritime applications.

The maneuver to reposition the ATS-1 satellite to 162 degrees east is expected to take about eight months to complete. Full communications with ATS-1 will be maintained throughout the move period with periodic adjustments of ground station antennas to keep the satellite in view.

Spaceport Citrus Survives January Freeze

NASA's Kennedy Space Center may be best known as the home of the Moon shots and Space Shuttle launches but it's also the site of some of the earliest commercial citrus activity in the country. The land which is now Kennedy Space Center is ideally located for citrus cultivation. Large, brackish lagoons and the Atlantic Ocean tend to insulate the area from the cold, and groves there have historically fared better than most others in the state.

It was no different this year following the recent invasion of the sunshine state by sub-freezing weather called the "Siberian Express." Fresh Florida citrus may be in short supply this year because of damage incurred by this weather but among the boxes of oranges and grapefruit shipped to satisfy the cravings of northern markets will be some from the nation's spaceport.

A preliminary assessment of the effects of the early January freeze on Kennedy's citrus groves indicates a fair portion of the crop will still be marketable as fresh fruit, rather than having to be sent to frozen concentrate plants like much of this season's crop on the mainland.

"I was pleasantly surprised," said Harvey Page, citrus manager at KSC and an employee of the U.S. Fish and Wildlife Service. "It appears we had minimal damage in the areas south of the VAB." The VAB—Vehicle Assembly Building—is where the Space Shuttle is readied for launch and three fifths of Kennedy's groves are located south of the huge structure.

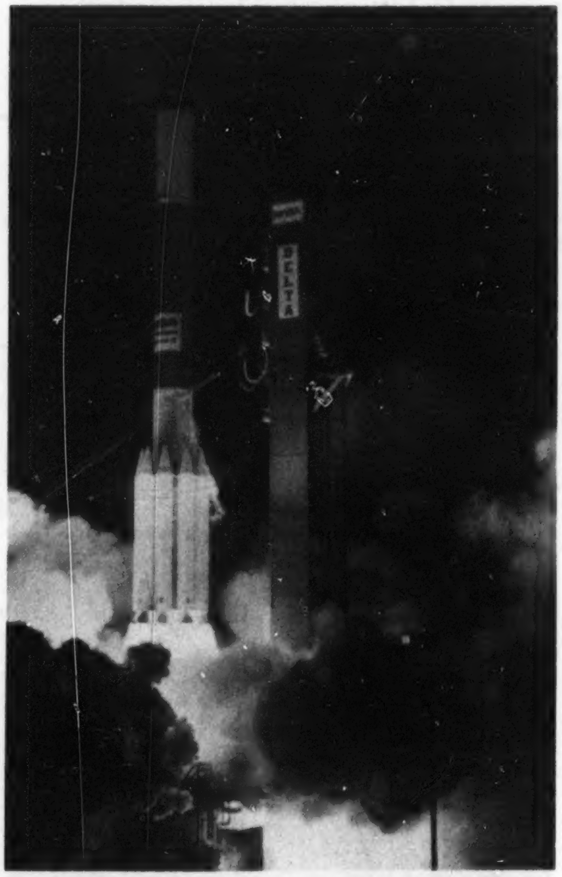
The first commercial groves on what is now the Kennedy Space Center were planted in the 1820's and they survived devastating freezes in 1835 and 1895. The area's ability to protect citrus trees from the cold weather encouraged other growers to plant groves on the Island.

By the time NASA began acquiring the property in 1962, there were groves scattered throughout the entire tract. They ranged in size from an acre and a half to several hundred acres. The fruit harvested from the Spaceport is among the finest grown in the state. "It's top quality Indian River fruit," says Page. "And as far as production, our groves are as good or better as any others of similar age."

For the first 10 years after the government acquired the property, the groves were leased out individually. Contractors competed for the right to operate the groves by bidding the percentage of the crop's value that would be turned over to the Government's general fund. Former owners were permitted to match the high bid.

But with a lot of small tracts, Page explained, it was uneconomical for the operators to invest in the long-term maintenance work necessary to ensure a grove's long-range health. So in the early 1970's the government grouped the groves into tracts of approximately 250 acres each. This made it economical and it became a contractual obligation for the winning bidder to perform tasks such as ditch maintenance and tree replacement.

A recent study by two agricultural experts employed by the state showed the Kennedy Space



First Launch of 1982—RCA Satcom E successfully launched aboard a Delta launch vehicle from the Eastern Space and Missile Center, Cape Canaveral Air Force Station, Fla., on Jan. 15. This satellite joins three other RCA commercial communications satellites in geosynchronous orbit as part of a diversified commercial communications system. The 24-channel satellite will be used to distribute video programming to cable television systems throughout the United States.

Center citrus crop contributes about $4.5 million annually to the local economy. This is based on production figures for the 1979-80 crop year. The on-tree value of the crop in that year was $2.5 million. The activities involved in harvesting the fruit and getting it to market were added to the on-tree value in determining the contribution to the area economy.

The fruit grown on the Space Center can end up at roadside shops which sell fresh citrus to tourists or in the produce and frozen foods section of your grocery store. Page said the biggest single producer in the spaceport crop is colored (red and pink) grapefruit. After that, Valencia oranges account for the most boxes. Other major varieties grown here include Navels, Temples, and Tangelos. The harvesting season begins in November and runs into July.

Telescope Cooling System Tested at Marshall

A large infrared telescope cooling system is undergoing thermal performance tests by the Space Sciences Laboratory, NASA's Marshall Space Flight Center, Huntsville, Ala. The cooling system, part of the Marshall-managed Helium-Cooled Infrared Telescope Experiment planned for launch with Spacelab 2 in November 1984, must maintain the infrared detectors at a super-cold temperature in order for the instrument to work.

James Jolley, an electronic technician in Marshall's Space Sciences Laboratory, examines the dewar section of a model of the Helium-Cooled Infrared Telescope Experiment. The actual dewar, a seven-foot-high container for liquid helium, is shown in the background. The dewar and other portions of the telescope cooling system are currently undergoing tests at Marshall.

"Since the telescope will be scanning newly forming stars and other sources of infrared radiation, which is emitted from warm objects, we have to make sure that the instrument doesn't measure infrared within itself," said co-Investigator Dr. Eugene Urban of the Space Sciences Laboratory. "So we have to keep parts of the telescope as cold as possible—about minus 450 degrees Fahrenheit."

Liquid helium, the coolant for the system, will be stored during the mission in a 250-liter container called a "dewar," a container sometimes compared to a thermos bottle, although far more sophisticated. It has vacuum jackets, insulation, thermal radiation shields and a highly complicated plumbing system.

Vaporized helium, drawn from the liquid in the dewar and nearly as cold as the liquid helium itself, will be circulated through various channels of the telescope to keep the instrument near absolute zero—the coldest possible temperature, at which all molecular action ceases.

The mechanical and cooling systems of the experiment are under Marshall Center development, while the telescope itself is being designed by the University of Arizona under a joint effort agreement among Marshall, the university and the Smithsonian Astrophysical Observatory. The University of Alabama at Huntsville is assisting in the development of the dewar system.

Among the tests being conducted is a measure of the flow rate of the helium as it boils off from the liquid, which is a determinant of thermal efficiency. Scientists are also measuring the temperatures of various components of the cooling system, to ensure that the super-cool conditions are evenly maintained.

"One of the objectives of these tests is to see how long the cooling system can store such a cold liquid," said Dr. Dan Ladner, a Space Sciences Laboratory physicist who assists Urban in the telescope experiment. "We want the cooling system to last for several weeks, because the dewar would be filled with liquid helium one or two weeks before the launch of Spacelab 2 and then undergo a mission of seven days. So we'd like to see a capability of the dewar to maintain the helium for perhaps 30 days."

Testing of the cooling system will continue until March.

Edelson Heads NASA Office of Space Science and Applications

Dr. Burton I. Edelson, senior vice president of COMSAT General Corp., was named NASA Associate Administrator for Space Science and Applications, effective Feb. 14. He succeeded Andrew J. Stofan, who had filled the position in an acting capacity. Stofan will remain as an advisor to Edelson until he moves into another senior management position within NASA.

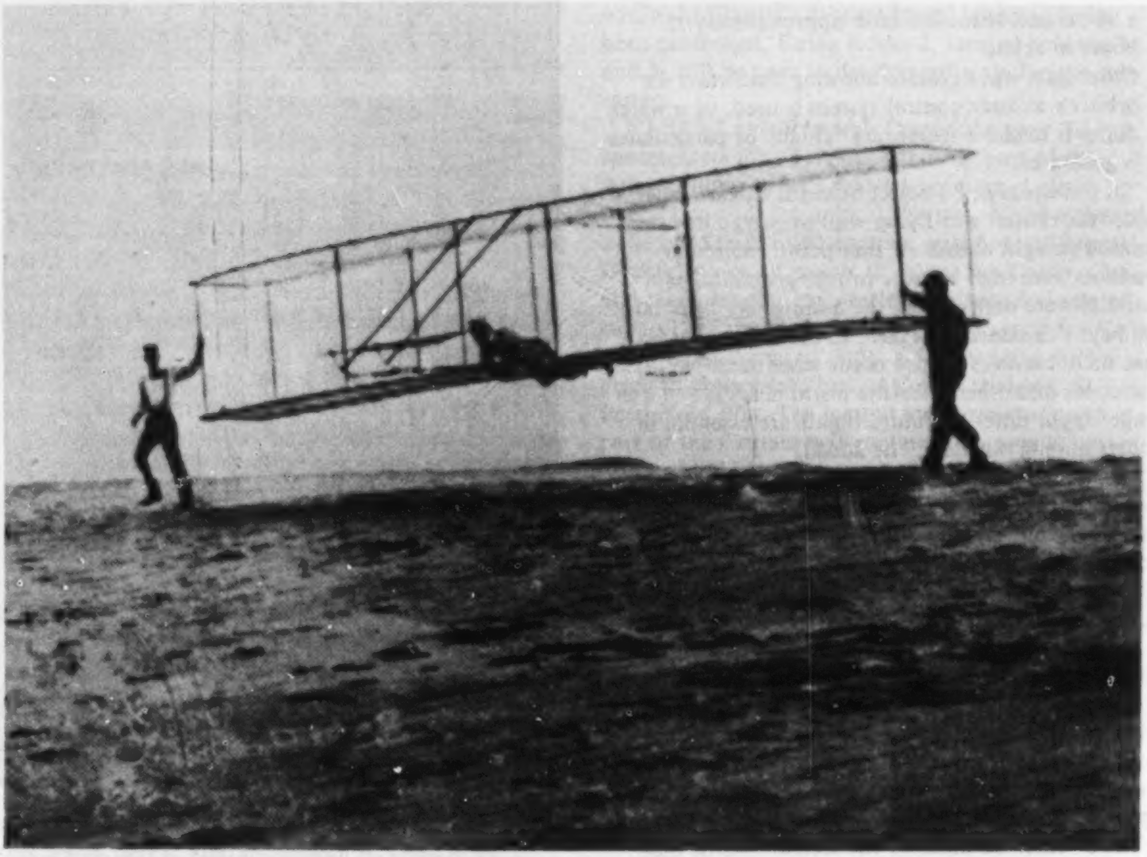
Edelson will be responsible for all of NASA's Space Science and Applications programs, as well as the activities of the Jet Propulsion Laboratory at Pasadena, Calif., and the Goddard Space Flight Center, Greenbelt, Md.

Edelson joined the Communications Satellite Corp. in 1967 as assistant director for COMSAT Laboratories and in 1973 was named director of COMSAT Laboratories.

In March 1979 he was elected vice president of COMSAT, and he assumed his present position in September 1980. Prior to joining COMSAT, he served as an engineering officer in the U.S. Navy with assignments on the staff of the National Aeronautics and Space Council at the White House and in the Office of Naval Research.

A graduate of the U.S. Naval Academy, Edelson earned his master's and doctorate degrees from Yale University.

He is a Fellow of the Institute of Electrical and Electronics Engineers and of the American Institute of Aeronautics and Astronautics. He is a member of several U.S. government advisory committees and recently served on the NASA Transition Team for the Reagan Administration.



Aviation Beginnings—Historic photo of the Wright brothers' third test glider being launched at Kill Devil Hills, N.C. in 1902. Wilbur Wright is at the controls, Orville Wright is at left, and William Tate (a local resident and friend of the Wright brothers) is at right. This photo was part of an exhibit of the Wright brothers work which was on display at the NASA Langley Visitor Center.

Monitor Provides Information on Shuttle Cargo Bay Environment

The Induced Environment Contamination Monitor taken into space aboard NASA's second Space Shuttle flight last November has provided the first information about the environment in the Shuttle orbiter's cargo bay in orbit.

The 10 instruments that comprise the monitor revealed the following:

- Humidity remained low in the cargo bay area during ascent and descent;
- Particulate matter of sizes greater than 5 micrometers were relatively absent from the bay, but particles less than 5 micrometers in diameter exceeded expectations;
- The cargo bay was successfully sealed from engine byproducts during liftoff and descent;
- Water molecules and other early-mission contaminants began boiling off rapidly and there was a 90-percent reduction after approximately 35 hours in orbit;
- Other data was obtained showing that when the orbiter's attitude control system is used, or a water dump is made, a temporary "cloud" of particulates is generated.

"In one instance," Project Scientist Edgar Miller said, "the orbiter was flying with the cargo bay open pointed straight ahead. At that point, molecular readouts were high because orbiter-generated particulates were deflected by the atmosphere back into the bay. Procedures will have to be worked out so that such instances do not occur when sensitive telescopes and other scientific instruments are in use; longer flight times on future flights are essential in understanding our data," he added.

Of major significance is the fact that every contamination producing activity such as thrust firings and water dumps, was clearly identified. This is important for it assures that during future missions, a differentiation can be made in evaluating contaminents that may be present from other sources.

The desk-sized package of sensors has been undergoing an extensive month-long analysis at NASA's Marshall Space Flight Center, Huntsville, Ala., where it was developed. A preliminary report on the data produced by the monitor during the Shuttle mission indicates that the monitor performed up to design expectations.

The 54-hour duration of the second Shuttle mission provided insufficient time to evaluate the potential breadth of contamination. The worst case potential for contamination is when the payload bay is exposed to the Sun, a condition which did not occur on the flight.

However, with the bay orientation that did exist, no surprises with regard to contamination were encountered, Miller added. "The contamination monitor systems performed normally throughout the mission and responded properly to all commands," he said. "The second Shuttle flight proved out the operation of the monitor, and its instruments added significantly to our knowledge of the orbiter's induced environment."

The third Shuttle flight will enhance the capability of the monitor because of the planned solar orientation of the bay producing high temperatures as compared with the relatively mild temperatures produced by the Earth orientation on the second Shuttle flight.

In the next mission, a planned seven-day flight, NASA scientists will gain more extensive data on the rate of decline in the amount of offgassing contaminants, the effects on the bay area in different thermal orientations, any effects of different

STS-3 Crew—Astronaut Jack R. Lousma (left), commander, and C. Gordon Fullerton, pilot, of the third Shuttle mission wearing modified USAF-type high altitude pressure garments in their Earth-bound Shuttle trainer at NASA's Johnson Space Center, Houston, Texas.

payloads and the effects of an extensively cleaned Orbiter Processing Facility. Time permitting during the flight, the monitor will map effluents utilizing the Remote Manipulator System to maneuver the monitor to selected points around the orbiter.

The monitor was returned to the Marshall Center Dec. 7, 1981, and placed in a "clean room" in the center's Test Laboratory where the instruments were removed for analysis and refurbishment. The film and samples to be analyzed in the laboratory were removed within a few hours after arrival at Marshall and the tape recorder containing the bulk of the data from the monitor was also removed and taken to Marshall's Computer Services Office for data reduction.

Women in Space—Photographic reproduction of a poster which pays tribute to women involved in the exploration and study of space. The eight women inset are part of NASA's astronaut corps. The two women at the top of the sphere are from NASA astronaut group 9 who began training in 1980. The other six astronauts are from Group 8, who began training in 1978. Clockwise from upper left are Mary L. Cleave, Bonnie J. Dunbar, Judith A. Resnick, Anna L. Fisher, Kathryn D. Sullivan, Rhea Seddon, Sally K. Ride, and Shannon W. Lucid. In the center is a "fish eye" lens view of the interior of the forward section of the flight deck of the Space Shuttle Columbia.

Contractor News

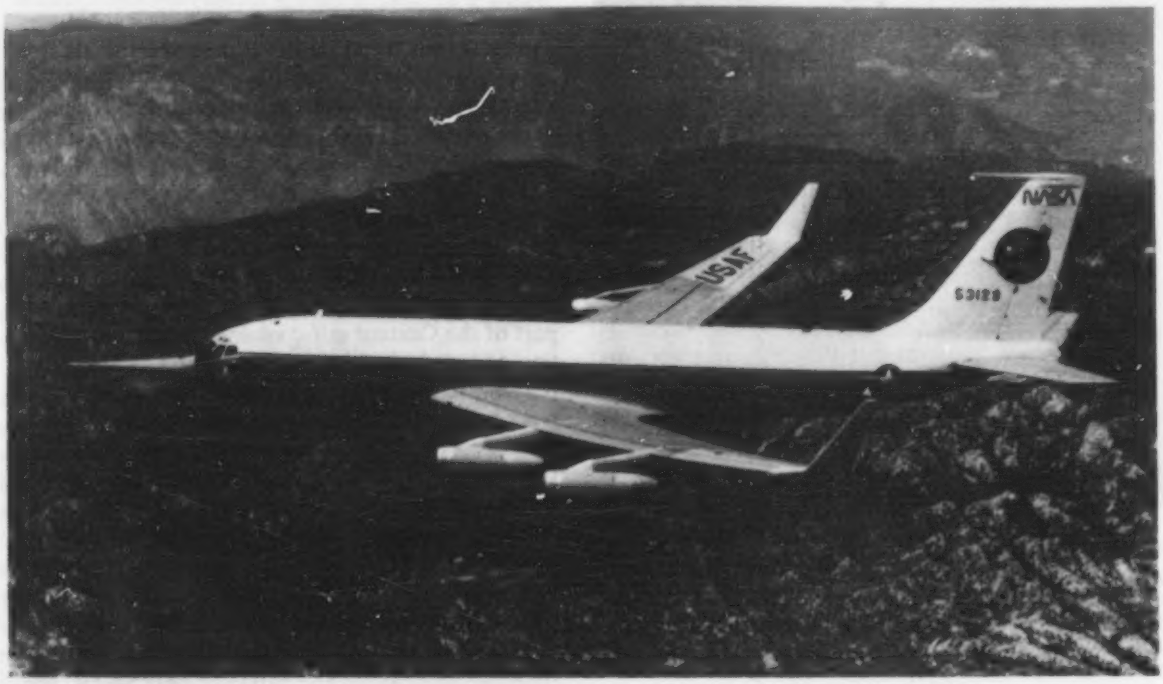
Martin Marietta Denver Aerospace, Denver, Colo., has been awarded a multi-million dollar addition to an existing contract with NASA's Kennedy Space Center, Fla. The value of the contract addition is $9,078,367, bringing the total value of the contract since 1975 to $111,193,217. Martin Marietta will provide the hardware for the checkout, control and monitor subsystem in Firing Room 3 of Kennedy's Space Shuttle Launch Control Center, which is now being prepared for regular Shuttle operations. The company will also provide some similar equipment for the Shuttle Launch Processing System at Vandenberg Air Force Base, California. The checkout, control and monitor subsystem is composed of consoles, mini-computers, a large mass storage unit and related equipment. It is used to actually process and launch the Space Shuttle. Firing Room 3 will be a duplicate of Firing Room 1, from which the Shuttle's developmental launches have been controlled. Firing Room 2, located between 1 and 3, will be used to develop software for the subsystem.

NASA's **Lewis Research Center** has awarded **two contracts** totaling $19,970,440 in **support of the Atlas Centaur launch vehicles** program. Launch operations and test support services will be managed under an $18,751,060 contract awarded to **General Dyamics Corp., Convair Division,** San Diego, Calif., and management, engineering, logistics and related support for the inertial measurement group for Centaur will be managed under a $1,219,380 contract given to **Honeywell, Inc., Avionics Division,** St. Petersburg, Fla. The inertial measurement group is part of the Centaur self-contained automatic navigation and guidance system. Both contracts are cost-plus-award-fee contracts and are continuations of work performed under earlier contracts. Both contracts become effective immediately, with the Convair contract continuing through June 1983 and Honeywell through December 1982.

Rockwell International Corp., Rocketdyne Division, Canoga Park, Calif., has been awarded a $2.9 million contract by NASA's Lewis Research Center, Cleveland, for engineering and logistics support for the Atlas launch vehicle. The 18-month cost-plus-fixed-fee contract became effective January 1, 1982. This procurement is a continuation of work performed under earlier contracts with Rocketdyne for similar services. The engineering and support activities will be carried out principally at the Rocketdyne plant in Canoga Park and at the Eastern Space and Missile Center, Florida. During the next 12 months the Atlas/Centaur launch vehicle is scheduled to launch three advanced INTELSAT Telecommunications Satellites. Atlas is the first stage of the Atlas/Centaur launch vehicle.

ILC Dover, Frederica, Del., has won a multimillion dollar contract to furnish protective clothing for workers exposed to hazardous conditions at NASA's John F. Kennedy Space Center and at the future Space Shuttle launch site at Vandenberg Air Force Base, Calif. The contract is for $4,792,910 and covers the period from Dec. 18, 1981 to Nov. 30, 1984. The firm will provide 436 garments known as SCAPE suits. SCAPE stands for Self-Contained Atmospheric Protective Ensemble. The suits are worn when workers are exposed to hazardous conditions, such as a spill of toxic fuel, and provide about two hours' protection. They provide temperature control and a constant supply of clean, filtered air. The contract is a joint NASA/Air Force procurement.

WILTECH of Florida Corp., Inc., Titusville, Fla., has been selected by NASA's Kennedy Space Center for negotiations leading to an award of a contract for Space Shuttle component refurbishment and chemical analysis services. The contract's value and an exact statement of work will be the subject of the negotiations. The new contract will cover maintenance and refurbishment of ground support equipment and some flight hardware, such as hydraulic and pneumatic valves, regulators, cylinders, filter assemblies, gauges and several types of hoses. The company will service items to serve as spares or line replaceable units. Other services will include sampling and chemical analysis of various fluids and gases to determine purity and identify contaminants. Examples of items to be sampled include both gaseous and liquid nitrogen, oxygen, helium, hydrogen and air. The new contract is the result of a small business set aside, and will extend for one year with three additional one year option periods. Services will be performed primarily at Kennedy Space Center and Cape Canaveral Air Force Station.



Winglet Flight Testing–NASA's Dryden Research Facility, Edwards, Calif., has flown the first flight of a modified USAF jet cargo/tanker aircraft that could provide significant fuel savings. Winglets, nine-foot long airfoil sections, have been attached to the wingtips of a KC135. They are expected to improve the overall performance of the aircraft in cruise flight by approximately eight percent. Winglets are two feet wide at the tip and six feet wide at the base and weigh about 215 pounds each. They are designed to convert a portion of the normal drag that is produced by the wingtip vortices into a forward force which increases the overall performance of the aircraft.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
Columbia (OV-102)	March 22	KSC	OSS-1
Columbia (OV-102)	July	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-C, Telesat-E

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Insat 1A	April 8	Delta	ESMC	India communications. Reimbursable.
NOAA-E/SAR	June	Atlas-73E	WSMC	NOAA/SAR weather. Reimbursable.
Navy 21	June	Scout	WSMC	DOD transit. Reimbursable. Callup.
Intelsat V-E	July	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Landsat-D	July	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August	Delta	ESMC	Canada communications. Reimbursable.
Westar-V	September	Delta	ESMC	Western Union communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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*Successful launch

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Leopold A. Hein and William N. Myers, NASA/MSFC	Amplified wind turbine apparatus	4,309,146	MSFC
Dean W. Sheibley NASA/LeRC	Formulated plastic separators for soluble electrode cells	4,309,372	LeRC
Stephen C. Irick, NASA/LaRC	Continuous self-locking spiral wound seal	4,309,039	LaRC
John H. Cantrell, Jr. and Joseph S. Heyman, NASA/LaRC, and William T. Yost and Michael A. Torbett, Univ. of Tenn.	Liquid-immersible electrostatic ultrasonic transducer	4,310,906	LaRC
Robert K. Robinson and Harry M. Thomlinson, Boeing Commercial Airplane Company, Seattle, Wash.	Fuselage structure using advanced technology metal matrix fiber reinforced composites	4,310,132	LaRC
Daniel L. Deadmore and Stanley G. Young NASA/LeRC	Silicon-slurry/aluminide coating	4,310,574	LeRC
Murzban D. Jhabvala, NASA/GSFC	Implantable electrical device	4,308,868	GSFC
Larry T. Taylor, Anne K. St. Clair, Vicki C. Carver and Thomas A. Furtsh, Virginia Poly-Technic Institute & State University Blacksburg, Va.	Electrically conductive palladium containing polyimide films	4,311,615	LaRC
Frank Lombardi, Caltech/JPL	Hermetic seal for a shaft	4,311,057	NRO
Amal M. Salama, Caltech-JPL	Improving the efficiency of silicon solar cells containing chromium	4,311,870	NRO
Thomas A. Shull, NASA/LaRC Hampton, Va.	Digital demodulator	4,313,103	LaRC
Walter Haeussermann, NASA/MSFC Huntsville, Ala.	Magnetic field control	4,313,077	MSFC

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Talking Wheelchair

A spinoff of technology developed at NASA's Ames Research Center, Mountain View, Calif., for advanced aircraft communications is an electronic system which produces highly intelligible synthesized speech. It is known familiarly as the "talking wheelchair" and formally as the Versatile Portable Speech Prosthesis (VPSP).* The VPSP was developed by Stanford University Medical Center, Stanford, California and Psycho-Linguistic Research Associates, Menlo Park, California with NASA-Ames funding assistance. Other participants include personnel of Ames Research Center, the NASA Biomedical Application Team at Stanford, and Children's Hospital at Stanford.

The wheelchair-mounted system consists of a word processor, a video screen, a voice synthesizer and a computer program which instructs the synthesizer how to produce intelligible sounds in response to user commands. To save time, the computer's memory contains 925 words plus a number of common phrases and questions from which users can construct messages; the memory can also store several thousand other words of the user's choice. Any word not already in the memory can be entered, one letter at a time, and the VPSP will pronounce it. Depending on the user's disability, message units are selected by operating a simple switch, a joystick or a keyboard. The completed message appears on the video screen; then the user activates the speech synthesizer which generates a voice with a somewhat mechanical tone. Continuing research aims at development of a more natural tone. With the keyboard, an experienced user can construct messages as rapidly as 30 words per minute.

The NASA technology used in the VPSP was developed as an aid to pilots who experience critical aircraft malfunctions. To free the pilot from the necessity for watching several instruments during the emergency, Ames Research Center developed experimental systems to provide synthesized voice readout of aircraft altitude, airspeed, descent rate and deviation from flight path. VPSP co-developer Dr. Carol Simpson, formerly a NASA researcher and now with Psycho-Linguistic Research Associates, applied this technology to the talking wheelchair.

The VPSP offers potential for people—some 1,500,000 in the United States alone—who have lost speech function as a result of such afflictions as stroke, cerebral palsy, muscular dystrophy, Parkinson's disease or multiple sclerosis. A company— Computers for the Physically Handicapped, Huntington Beach, California—has expressed interest in commercial production of the VPSP system and negotiations are underway.

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*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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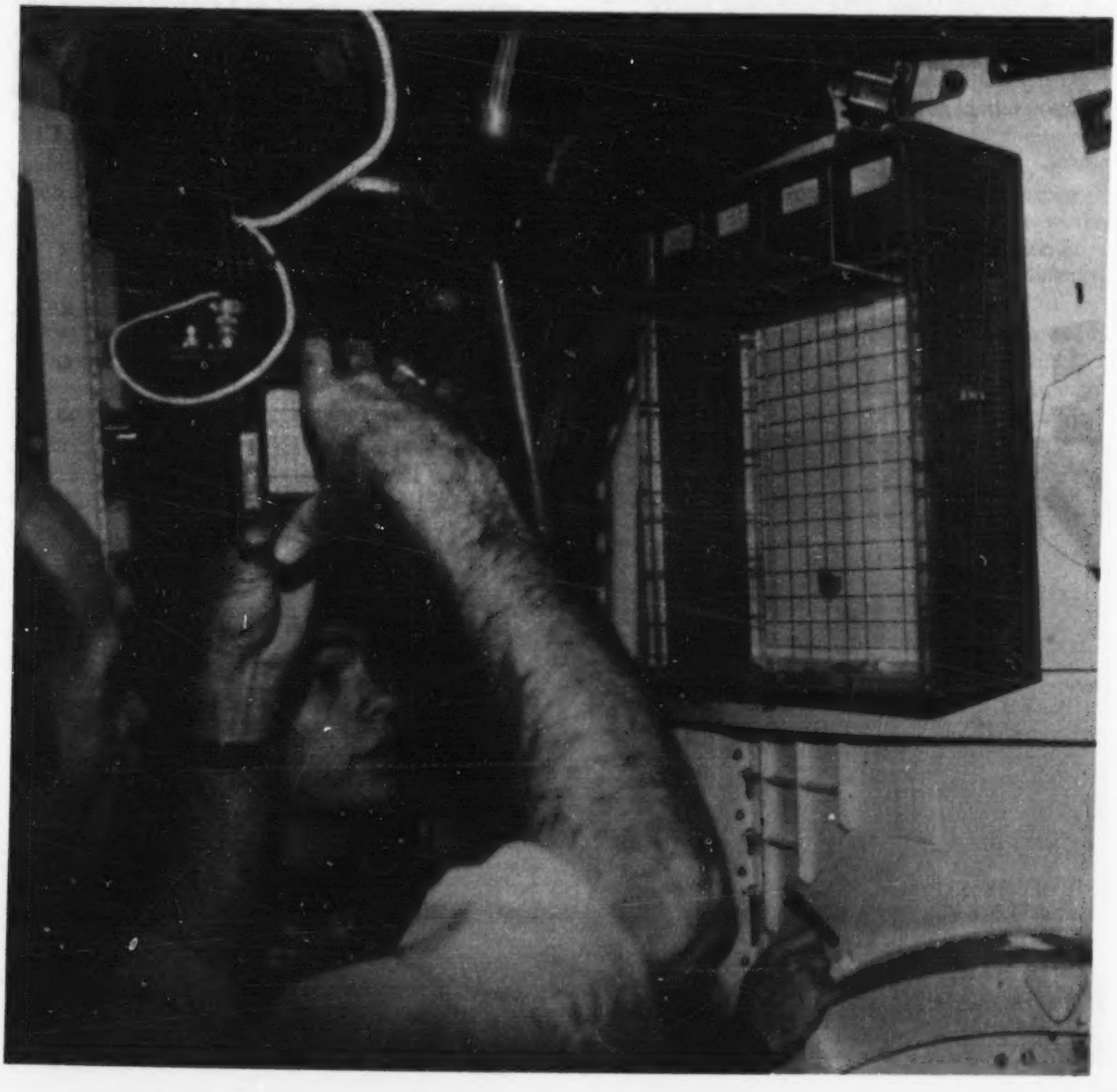

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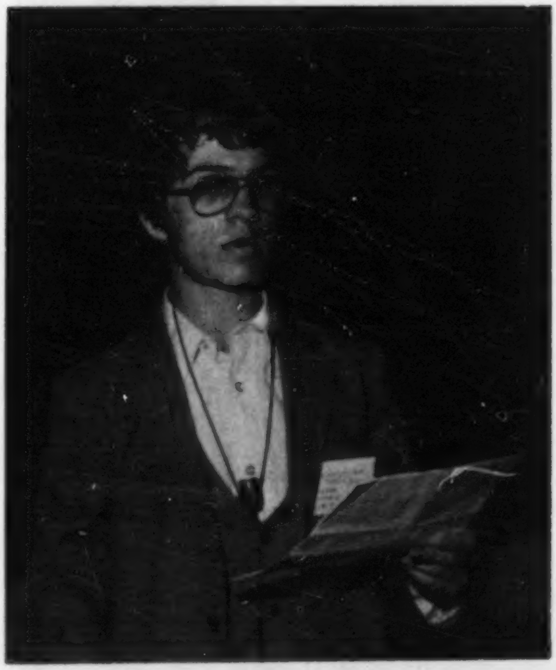
About the Cover

Todd Nelson, one of 10 winners of NASA's first Space Shuttle Student Involvement Project, watches as NASA photographer Don Yeates adjusts the data acquisition camera that wil be part of Nelson's experiment flying on board the third Space Shuttle flight, scheduled for launch March 22. Honeywell Avionics Division, Minneapolis, is the corporate sponsor of Todd's experiment which studies the affect of weightlessness on the flight of insects.

Below, Todd answers queries at an STS-3 experiments briefing held at Johnson on Feb. 25. Todd is an 18-year old senior from Southland Public School, Adams, Minn. His entry for the 1980-81 contest was among 1,500 entries submitted.



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Student Experiment to Fly on Third Shuttle Mission

The third flight of NASA's Space Shuttle, scheduled for launch March 22, will have an exceptional meaning for a high school student from Rose Creek, Minn. He will have a scientific experiment flying on it. The experiment, "Insects in Flight Motion Study," was devised by Todd E. Nelson, an 18-year-old senior from Southland Public School, Adams, Minn., one of 10 finalists in the first national Space Shuttle Student Involvement Project.

The Shuttle Student Involvement Project for Secondary Schools is a joint venture of NASA and the National Science Teachers Association and is designed to stimulate the study of science and technology in the nation's secondary schools.

The insects to be examined are the velvetbean caterpillar moth and the honeybee drone. The object of the experiment is to study these two species under uniform conditions of light, temperature and pressure; the variable being the absence of gravity in space.

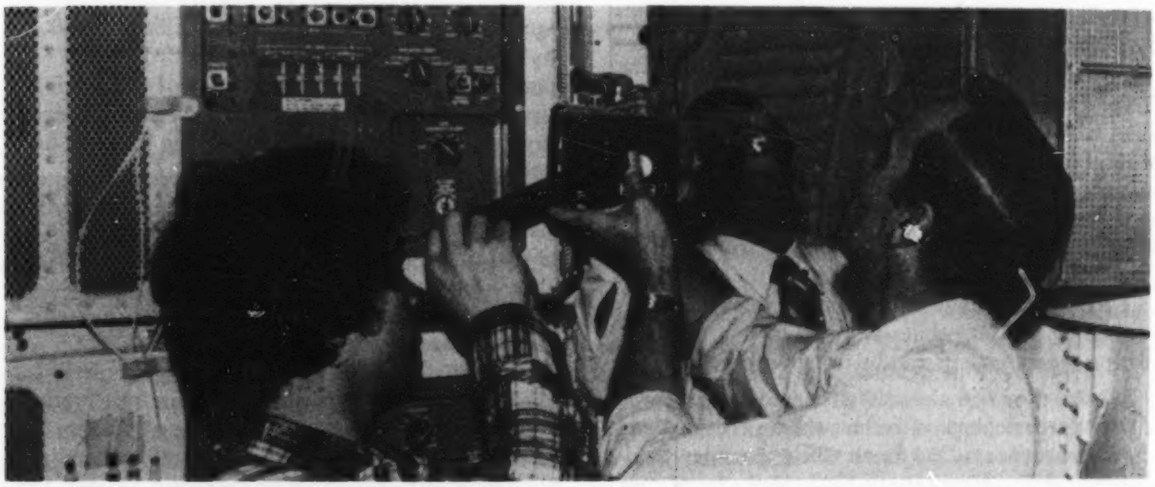
The experiment will focus on the flight behavior in zero gravity of two species of flying insects with differing ratios of body mass to wing area. Gravitational force is of primary importance for orientation and stable free flight of insects. The experiment will provide new aspects to research on responses of flying insects to changes in gravity which has been worked on at NASA's Ames Research Center, Mountain View, Calif.

Ten insects of each species will be carried in separate canisters, which will be stored in a Shuttle locker. The crew of the Space Shuttle (Jack Lousma and Gordon Fullerton) will remove the canisters from the storage locker and attach them to the middeck wall where they will observe the insects and film them with a data acquisition camera as the insects' behavior adapts to the zero gravity environment.

To broaden participation in the Shuttle Student Involvement Project, NASA solicited U.S. industrial firms and other groups to sponsor the development of the student experiments. Sponsors were asked to assign a company scientist to work with the student; fund the development of the experiment, including necessary hardware; provide travel funds to take the student to appropriate NASA installations during experiment development; and give the student assistance in analyzing post-flight data and preparing a final report.

The Avionics Division of Honeywell, Inc., of Minneapolis, agreed to sponsor Nelson's insect experiment. During the past six months Nelson has worked with Robert Moulton and Dr. Robert Peterson at Honeywell's headquarters to ready the experiment for flight.

Others who have assisted Nelson in this project are Robert D. Roberts, his teacher-advisor, and Dr. Bill Williams of the Biosystems Division at Ames Research Center. Assisting with Shuttle payload integration was Chris Perner and John Jackson of the Crew Integration Section, NASA Johnson Space Center, Houston.



Todd Nelson looks through the lens of the data acquisition camera to be used when his experiment flies aboard the Columbia. NASA photographer, Don Yeates, holds the camera and in the background John Jackson of NASA's flight integration office assists.

Third Shuttle Prime Experiments

Key experiments carried aboard the third flight of the Space Shuttle Columbia include: OSS-1 (for the Office of Space Science), a payload which consists of nine different experiments; the electrophoresis experiment verification test; monodisperse latex reactor; induced environment contamination monitor; catalytic surface effects experiment; dynamic acoustic and thermal environment experiment; getaway special verification payload; and the Heflex bioengineering test. Following are synopses of these key experiments sheduled for flight March 22.

OSS-1

The primary payload carried aboard the third Space Shuttle flight is OSS-1 (for Office of Space Science). Most of the OSS-1 scientific equipment will be mounted on a pallet designed and provided by the European Space Agency. The experiments will check factors that cannot be pretested on Earth but that may affect future scientific work on board the Shuttle. These include reactions of orbiter and payload to thermal variations greater than ever experienced on Earth; effects of an orbiter-generated "cloud" of particles and gases, if any; and the degree of electrical charging on the spacecraft.

The experiments which make up the OSS-1 payload are: plasma diagnostics package, vehicle charging and potential, Shuttle Spacelab induced atmosphere, solar ultraviolet spectral irradiance monitor, solar flare x-ray polarimeter, contamination monitor package, microbrasion foil experiment, thermal canister, and plant lignification in weightlessness.

The **Plasma Diagnostics Package** (PDP) experiment will define the electromagnetic environment around the orbiter at its parking-orbit altitude in the plasma. The orbiter is a much larger spacecraft than those used in the past for field measurements and as such its package is liable to distort electromagnetic fields and plasmas, leaving a wake in the ionosphere. The PDP will attempt to understand the wakes formed by various orbiter attitudes so that future plasma measurements can be interpreted accurately.

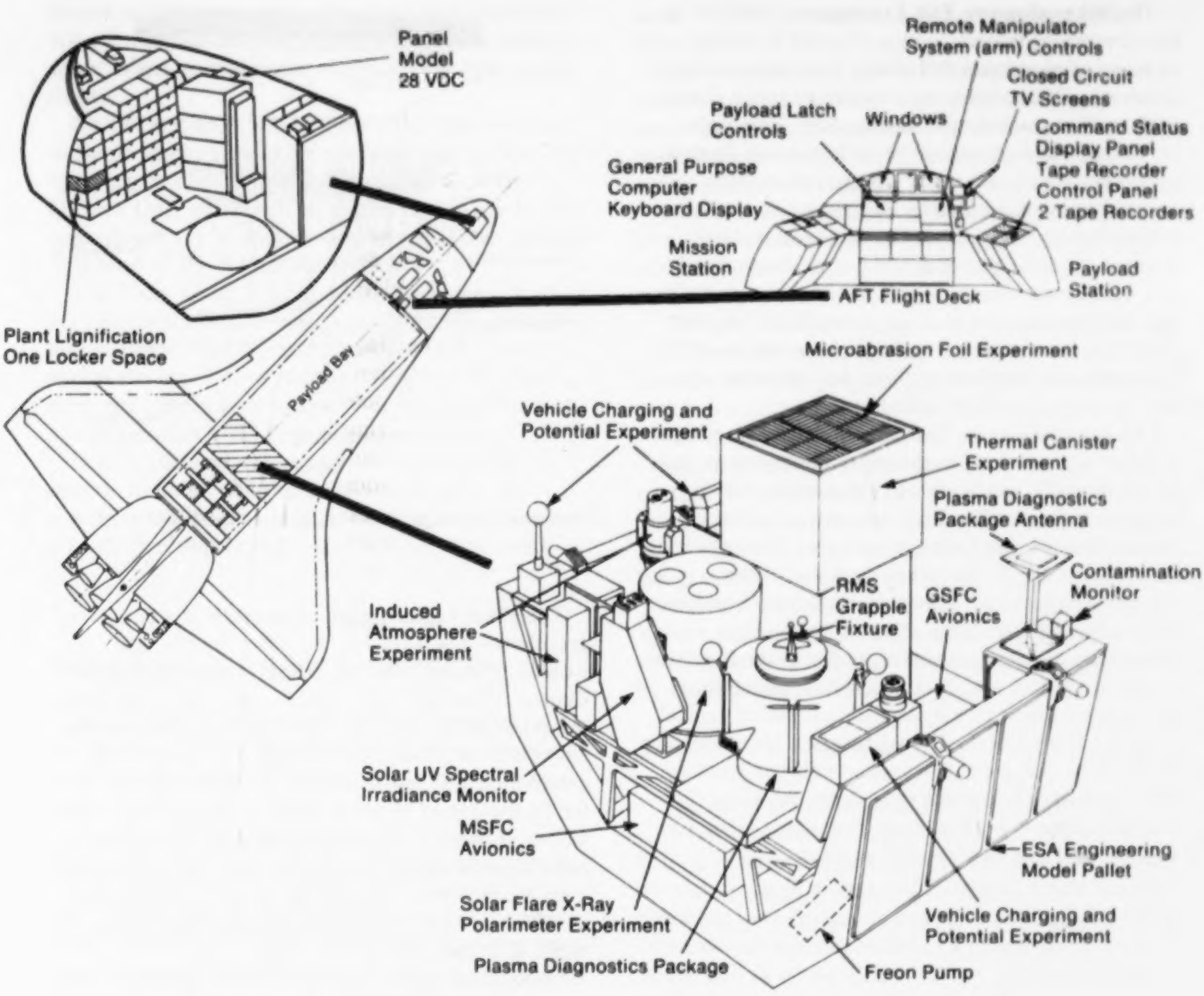
It is believed that the orbiter's speed should cause a bow shock analogous to that which is formed on the sunward side of the Earth where the solar wind compresses Earth's magnetic field. In the latter case, it is the medium that is moving, whereas with the Shuttle, it is the vehicle that is moving, but the physics are similar. The orbiter is expected to generate low-level dc magnetic fields from the 28 V power system and dc electric fields from its motion through the ionized plasma. These fields and resulting acceleration of particles will be measured.

The STS-3 crew will maneuver the Remote Manipulator System to grapple the PDP, unlatch it, and move it around the predetermined sweeps to map the orbiter's fields in and near the cargo bay and out to 15 meters distance, the longest reach of the arm. Then the PDP will be restowed for return to Earth.

The **Vehicle Charging and Potential** experiment will study electrification phenomena by inducing changes in electrical potential in a controlled manner. Part of the experiment is the first low-power Fast-Pulse Electron Gun to be used in space. Pulses will be varied in duration and emitted at varying repetition rates. The beam width will be in the range of 5-10 degrees. Two charge and current probes, mounted on diagonally opposite corners of the pallet, may react like the orbiter's surfaces. The sensors will record electrical effects that may be like those on the orbiter itself.

The **Shuttle-Spacelab Induced Atmosphere** will define the optical properties of an orbiter-induced atmosphere. A similar experiment with an identical instrument was conducted on Skylab; no contaminants could be found in a direction of 90 degrees to the Sun down to approximately a factor of 100 below the visible threshold. The orbiter may be equally clean. The twin of the Skylab instrument to be flown on OSS-1 includes two elements: a photoelectric polarimeter to measure the intensity of light and its polarization in 10 colors between 400 and 820 nanometers; and a bore-sighted 16-mm camera for concurrent photography of star fields to establish the instrument's pointing direction. The instrument will be operated by sweeping fore and aft through the orbiter's vertical axis.

The purpose of the **Solar Ultraviolet Spectral Irradiance Monitor** (SUSIM), which will be flown several times, is to improve the accuracy of far-ultraviolet flux measurements to some 10 percent or better between 140 and 210 nm by comparing these fluxes to the relatively stable fluxes above that wavelength. The SUSIM contains two complete observing systems. One makes constant observations; the second takes only a brief glimpse of the Sun once a day to check that the other has not been blinded. It will scan the solar spectrum between 120 and 400 nm with a spectral resolution of 0.1 nm. Ultraviolet, absorbed in the outer reaches of Earth's


Panel
Model
28 VDC
Plant Lignification
One Locker Space
Payload Bay
Remote Manipulator
System (arm) Controls
Closed Circuit
TV Screens
Payload Latch
Controls
Windows
Command Status
Display Panel
Tape Recorder
Control Panel
2 Tape Recorders
General Purpose
Computer
Keyboard Display
Mission
Station
Payload
Station
AFT Flight Deck
Microabrasion Foil Experiment
Vehicle Charging and
Potential Experiment
Thermal Canister
Experiment
Plasma Diagnostics
Package Antenna
Contamination
Monitor
RMS
Grapple
Fixture
GSFC
Avionics
Induced
Atmosphere
Experiment
Solar UV Spectral
Irradiance Monitor
MSFC
Avionics
ESA Engineering
Model Pallet
Solar Flare X-Ray
Polarimeter Experiment
Vehicle Charging and
Potential Experiment
Plasma Diagnostics Package
Freon Pump

Payload configuration for the OSS-1 experiments to be flown aboard the third flight of the Space Shuttle Columbia.

atmosphere, plays an important role in determining the physical properties of the upper atmosphere and, by implication, in influencing the condition of the lower levels that affect human life and livelihood.

The **Solar Flare X-ray Polarimeter** experiment is composed of three analyzers which will produce the most thorough sampling of flare X-rays ever made. Heretofore, because of the limited capacity of satellites, only one such analyzer could be flown at a time. This 3-unit device will register the scattering of a beam of incident photons. The redundant, cross-referenced data should provide an unambiguous decision. The data collected from this experiment will help scientists understand the polarization of X-rays emitted during a solar flare and provide a major advance in understanding the physical processes that drive solar flares.

The **Contamination Monitor Package** will assess the mass buildup of condensible volatile materials on surfaces in the Shuttle bay during all phases of ascent; and correlate mass buildup with payload activities, Shuttle operational events, OSS-1 instrument performance degradation and Induced Environment Contamination Monitor results. Correlation with other pallet instrumentation can provide valuable insight as to how molecular contamination affects instrument performance.

The **Microabrasion Foil Experiment** (MFE) is an extraterrestrial material study. The MFE is constructed of aluminum foil sheets bonded to a plastic substrate. These sheets are exposed to space during flight and examined after the landing. Very light particles cannot penetrate the foil, but will form a hypervelocity impact crater on the foil surface. Somewhat heavier particles will penetrate the foil to a depth which depends on the particle's incident velocity. Heavier particles will not be fragmented and will survive almost intact, whereas icy particles will readily fragment to form a number of impact craters in the rear Kapton sheet. An analysis of the fragmentation profiles on the sheet will yield information on the particles' densities.

The purpose of the **Thermal Canister Experiment** is to try a method of temperature management that might keep all instruments in the payload bay in a benign condition. The TCE canister contains five elements: fixed conductance heat pipe for equalizing the temperature of the interior canister walls; variable conductance heat pipe for controlling heat flow from the interior to external radiators, radiators and radiator heat pipes for discarding heat to space; control and data acquisition electronics; and heaters inside to simulate the output of typical scientific instruments. The engineering objectives for TCE are to maintain the canister wall temperature between 5 and 25 degrees C, ±3 degrees C; and maintain control with internal heat loads from 100 watts in sunlight to 400 watts in shade.

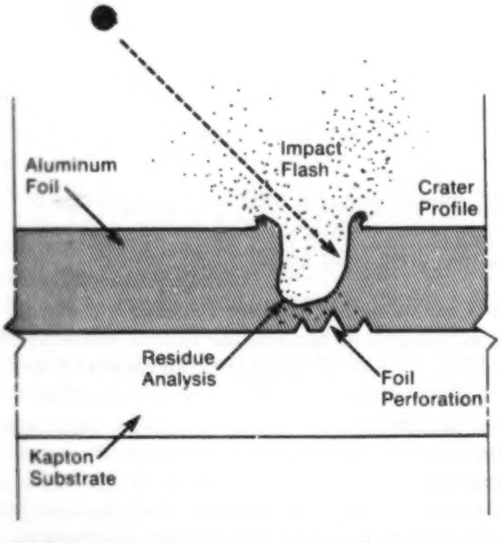


Diagram illustrating particle impact on OSS-1 Microabrasion Foil Experiment.

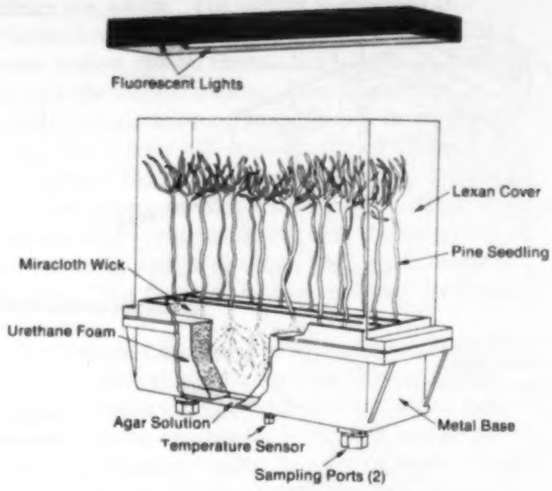


Illustration of OSS-1's Plant Lignification experiment.

The **Plant Lignification** experiment is a compact greenhouse managed by Dr. John Tremor and Ronald Mancini, both of NASA's Ames Research Center, Mountain View, Calif., in conjunction with the principal investigator, Dr. Joe R. Cowles of the University of Houston. The flight of the orbiting greenhouse will test the effect of weightlessness on the formation of lignin in plants. Lignin is the woody substance in plants which allows them to grow upward against the pull of gravity, gives them their characteristic shapes and supports the organs which carry food and chemicals. It makes up as much as 30 percent of plant tissue.

Controlling lignin is economically attractive because lignin interferes with extraction of wood fibers for the production of paper and plastics. In many plants it also competes with food production. Gravity appears to be a fundamental stimulus for the production of lignin. By comparing Earth-grown and space-grown plants, scientists hope to better understand the development of lignin and to some day learn to regulate it. Scientists believe that lignin production will decrease in space, but that plants still will grow upward in response to the growth unit's artificial sunlight. They are not sure how roots, less responsive to light, will grow. U.S. scientists have not had the opportunity to test their theories in the weightless environment of space.

A total of 96 plants will be carried aboard the orbiter Columbia in six 25-centimeter (10-inch) plant growth chambers. Oat and mung bean seeds and young slash pine seedlings will be planted just before launch in the rectangular, terrarium-like chambers. All are compact species able to grow in the limited space available and under relatively low light conditions.

Sixteen seedlings will be planted in each chamber, in sandwiches of moist sponge and filter paper. The chambers will be sealed and placed in the Plant Growth Unit which will be loaded late in the launch countdown into a single locker space on the forward bulkhead of the orbiter's mid-deck.

The Plant Growth Unit, which is the size of a filing cabinet drawer, is completely automatic, requiring no flight crew interaction. All data are stored within the experiment package. The unit provides light and temperature control and includes batteries, a tape recorder and controlling electronics.

During the seven-day mission the plants will receive 14 hours daily of artificial sunlight. Researchers will be able to tell from the data whether growth direction varied under light or dark conditions.

Electrophoresis Experiment Verification Test

An experiment which will test the operation of hardware used in separating biological materials on-orbit will be conducted on the third flight of the Space Shuttle.

The Electrophoresis Experiment Verification Test, designed to certify the process of separating cells according to their molecular charge, is part of the Materials Processing in Space Program at the Marshall Space Flight Center, Huntsville, Ala. The hardware was previously flown on the Apollo-Soyuz Test Project in 1976.

The experiment utilizes an electric field to separate cells and other biological materials in a fluid without damaging the cells and is designed to improve the separation of cells for the study of cell biology, immunology and medical research.

Electrophoresis is difficult on Earth because heat produced by the electric field causes buoyancy and re-mixing of the cells and fluid, thereby defeating the process. In space, even though the process still produces heat and density variation in the fluid, the separation is not disturbed because buoyancy is absent in the low gravity environment.

The experiment to be flown on STS-3 consists of an electrophoresis processing unit with glass columns where the separation takes place, camera and film to document the process, and a cryogenic unit to freeze and store the samples after separation. The equipment will be stowed in the mid-deck area of the Shuttle orbiter crew cabin.

One crewman will activate the equipment, insert the biological samples in one of the unit's glass columns and place the columns in the freezer after the experiment is completed. The duration of each separation is one hour.

The samples to be used in the equipment verification test include fixed red blood cells supplied by the Marshall Center and live kidney cells provided by NASA's Johnson Space Flight Center, Houston.

Two televised processing runs will be shown of the red blood cells being separated. The telecasts will provide the principal investigators with the ability to make changes as needed.

The electrophoresis unit will be removed from the orbiter within three hours after landing. The frozen columns will then to be delivered to the Marshall and Johnson Centers for analysis. The flight hardware will be returned to Marshall for refurbishment for planned future Shuttle flights.

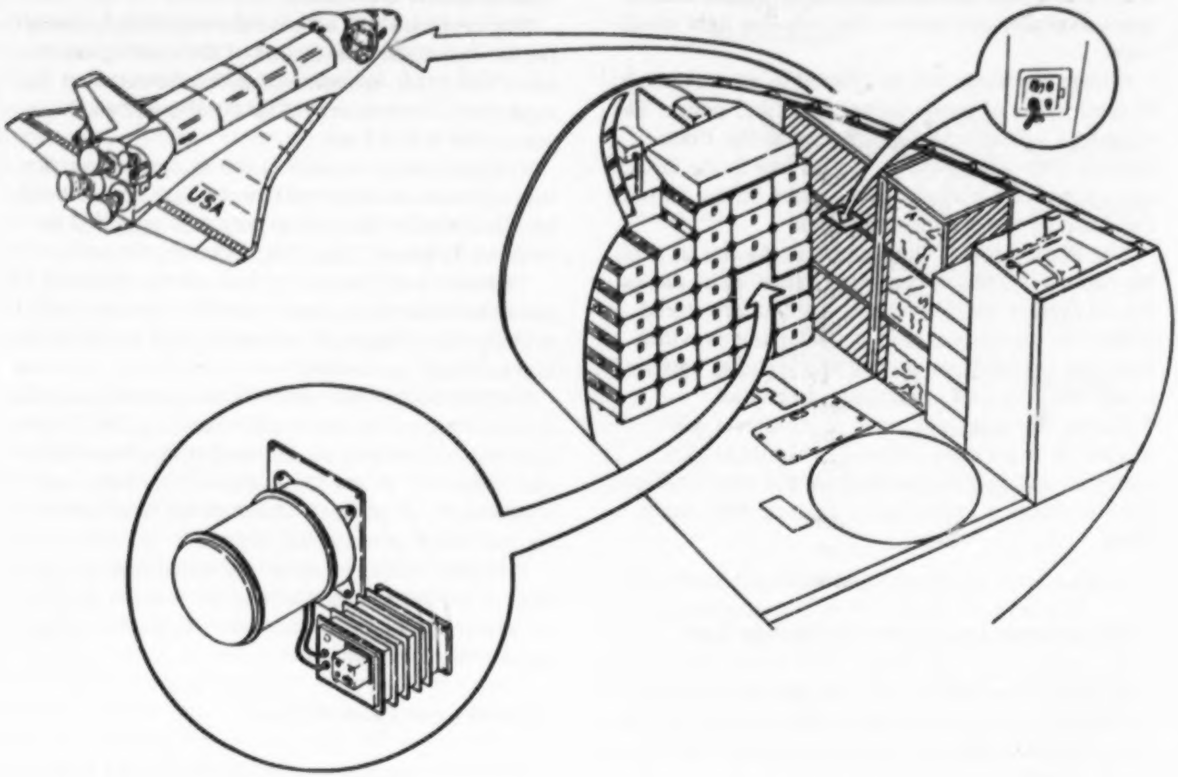
Principal investigators on the experiment are Dr. Robert Snyder at Marshall and Dr. Dennis Morrison at Johnson. The experiment was designed and built by the Marshall Center.

Monodisperse Latex Reactor

The Monodisperse Latex Reactor (MLR) is a materials processing facility which will allow scientists to determine if low gravity will improve the production of large diameter monodisperse (all exactly the same size) latexes. A latex is a suspension of very tiny (micron size-$\approx$0.00004 in.) plastic balls in a liquid, such as water. These latexes have important medical research and industrial applications. However, under Earth's gravity these latexes can only be produced to a size of about 2 microns and still be kept monodisperse. Specifically, the MLR experiment will provide an opportunity to study kinetics of reaction without the effects of buoyance and sedimentation, which affect processing on Earth. It can then be determined and possibly demonstrated that without these complicating factors larger monospheres can be achieved.

The MLR will be used to conduct investigations on a series of four early Shuttle flights. Particles produced on one flight will be used as "seed" for the next flight.

The flight equipment consists of an Experiment Apparatus Container (EAC) and a Support Electronics Package (SEP). The EAC (mass 42.3 kg, size 0.416 m dia. × 0.495 m high) contains four



Space Shuttle accommodations for the Monodisperse Latex Reactor flown aboard the third flight in March.

separate, independently operated chemical reactors. These reactors are cylinders, wrapped with heating tape, that contain stirrers for agitation and pistons for measuring volume change during reaction.

Each of the reactors will produce latex from 100 cc of the chemical recipe loaded in each. The SEP (mass 13.6 kg, size 0.346 m × 0.265 × 0.300 m) contains a preprogrammed microprocessor which controls the experiment operation after being manually turned on by the crew. The SEP also contains a recorder which stores all data produced during operation of the experiment.

The two components of the flight equipment, the Experiment Apparatus Container (EAC) and the Support Electronics Package (SEP), will occupy the space of three standard mid-deck lockers. Electrical power will be provided to the experiment from an overhead panel in the mid-deck.

The two units will be attached to orbiter wall using adapter plates. Heat produced by the chemical reaction within the MLR reactors will be dissipated passively through the normal air flow in the mid-deck during the 14 hours of operation. Thus, MLR demands on the Shuttles are simple and impose no constraints on the major mission activities.

The ground and flight operations required for MLR are: as follows. First, the four independent reactors inside the EAC will be loaded with appropriate ingredients at the launch site laboratory. When ready for flight, the MLR will be transported to the launch pad and installed in the Shuttle approximately 48 hours before launch. The experiment will be switched on by the crew at any time during a low-gravity period of the mission, will run under the preprogrammed microprocessor control for 14 hours, and will turn itself off. The data generated during the experiment will be recorded on the tape recorder located in the SEP.

The MLR will be removed from the Shuttle at the landing site as soon as possible after landing and returned to the principal investigator for sample and data analysis.

After a cleanup and refurbishment of the flight equipment and loading with a new chemical recipe, the MLR will be ready for another flight.

During the growth phase the latex spheres are required to be kept in a state of suspension, generally achieved through stirring, to avoid "creaming" (floating) at the beginning, and "settling" (sinking) near the end of the process. For very small particles up to $0.5\mu m$ (≈ 0.00002 in.) in diameter, the stirring is not necessary. However, for particles of moderate sizes gentle mechanical agitation is required which imposes no problem for earth-bound processing.

Rapid agitation required to keep larger particles in suspension increases the changes of collision between the particles. During growth the particles are spongy and sticky so they deform after collision, do not rebound, and therefore tend to stick together to form clusters of particles. This tendency can be reduced by increasing the quantity of emulsifier, but doing this increases the danger of generating a new crop of particles. This "new crop" of tiny particles also grows along with the seed monodisperse particles and results in a latex with particles of various sizes—therefore, no longer monodisperse.

It is anticipated that the problems encountered with the production of large size particles can be alleviated by carrying out the process in a low gravity environment of space. In space, with the absence of buoyancy and sedimentation, the large size particles will have no tendency to either "cream" or "settle" and could be kept in suspension with no agitation. This would reduce the chance of particle collision which in turn will allow reduction of emulsifier quantity, thereby eliminating the danger of new crop generation.

The experiment will be conducted by Dr. John W. Vanderhoff of Lehigh University as principal investigator along with co-investigators, Fortunato J. Micale and Mohamed S. El-Aasser, also from Lehigh.

The responsibility for providing the MLR flight equipment and testing of the experiment in various phases of development lies with the Materials Processing in Space Project Office and the mission integration activities required to support the MLR flights with the Spacelab Payload Project Office (SPPO), both of NASA's Marshall Space Flight Center, Huntsville.

Induced Environment Contamination Monitor (IECM)

The Induced Environment Contamination Monitor is a desk-sized detector containing 10 instruments for contaminants in and around the Space Shuttle orbiter cargo bay which might adversely affect delicate experiments being carried aboard.

The monitor, developed by the Marshall Space Flight Center, Huntsville, Ala., will be placed in the Shuttle cargo bay on the second, third and fourth missions. It also will be a part of Spacelab missions one and two. It will operate during pre-launch, ascent, on-orbit, descent and post-landing.

With the monitor instrumentation, contaminant sources may be identified and eliminated. It will also provide data on the interaction of the induced and natural environments, and will provide critical data for planning of future Shuttle payloads.

Contaminants to be monitored during Shuttle flights include any outgassing from materials within the Shuttle, as well as gases from the reaction jets which control the vehicle in orbit.

The on-orbit measurements include molecular return flux, background spectral intensity, molecular deposition and optical surface effects. During the other mission phases, dew point, humidity, aerosol content and trace gas will be measured, as well as optical surface effects and molecular deposition.

After each Shuttle flight, the monitor will be returned to Marshall for refurbishment. The flight data will be combined with Orbiter data furnished by the Johnson Space Center, Houston, for a comprehensive analysis.

Catalytic Surface Effects (CSE) Experiment

A strong shockwave encompasses the Shuttle orbiter during the atmospheric reentry maneuver. The shock wave severely compresses and heats the air flowing through it, causing the molecules to dissociate and react chemically with each other.

Computations show that as the dissociated atomic oxygen approaches the cooler regions of flow adjacent to the orbiter, the atomic oxygen fails to recombine into molecular oxygen.

This experiment investigates the chemical reaction caused by impingement of atomic oxygen on the Shuttle thermal protection system. The tiles were designed under the assumption that the atomic oxygen would recombine at the thermal protection system wall. This chemical reaction releases additional heat which results in higher thermal protection system temperatures. In this case, the surface is referred to as being a catalytic surface allowing the chemical reaction to take place.

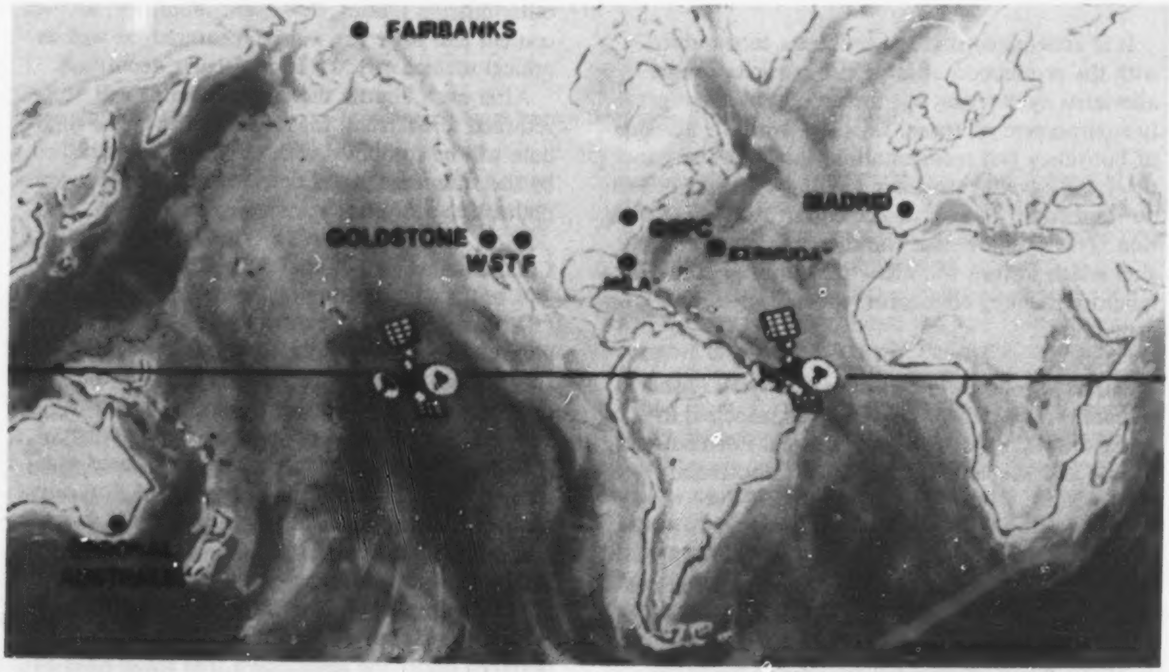
If the thermal protection system surface is non-catalytic, then atomic oxygen will not recombine into molecular oxygen and the heating rates will be lowered. Thus, the temperature of the orbiter during reentry will be lower. With lower temperatures, orbiter thermal protection system weight could be reduced, its flight envelope could be expanded, or greater reusability could result.

The Catalytic Surface Effects uses two baseline tiles, selected from those having development flight instrumentation thermocouples, located on or near the orbiter lower fuselage centerline. These tiles are sprayed with an overcoating mixture of chrome-iron-spinel, a highly efficient catalytic material and a vinyl acetate binder which will protect the overcoat during ground operations. The mixture is compatible with the existing tile and coating and will not alter the thermal or mechanical properties of the uncoated portions of the thermal protection system. During orbiter ascent, the vinyl acetate will burn off the tile surface, leaving the chrome-iron-spinel exposed.

Thermocouple measurements recorded during reentry will be used to determine Catalytic Surface Effects performance. Comparisons of this experiment data with data taken on previous flights from uncoated tiles will aid in the performance evaluation.

Dynamic, Acoustic and Thermal Evironment (DATE) Experiment

Predictions of payload environments will facilitate payload development and reduce the need for ultraconservative design and test. The Dynamic, Acoustic and Thermal Environment experiment will collect information for use in making credible predictions of cargo-bay environments. These environments are neither constant nor consistent throughout the bay and are influenced by interactions between cargo elements. The experiment instrumentation includes accelerometers, microphones, thermocouples and strain gages. Sensor outputs will be recorded for post-flight interpretation. The Goddard Space Flight Center, Greenbelt, Md., will be responsible for the data reduction. Principal technologist is W. Bangs, Goddard.



Improved Shuttle Communications– Artist concept of view of Earth from space showing equatorial on-orbit position of Tracking and Data Relay Satellite System spacecraft. Scheduled for launch in Jan. 1983 aboard orbiter Challenger, these new satellites ultimately will replace more than half the existing ground tracking stations and will provide improved communications to and from the Shuttle and from other Shuttle launches at a greatly reduced cost.

Getaway Special Flight Verification Payload

The purpose of the Getaway Special Flight Verification Payload is to monitor the conditions inside and outside the payload canister. Getaway Specials are small self-contained payloads which will be flown on the Space Shuttle on a space-available basis beginning as early as the STS-4 mission. They are available to industry, educational organizations, and domestic and foreign governments for legitimate scientific purposes. More than 320 have been sold to date.

The standard GAS container is made of aluminum and provides the means of installing small experiments in the orbiter bay as well as protecting the orbiter and crew. The container provides for internal pressure which can be varied from near vacuum to about 1 atmosphere. It also provides thermal protection for the experimental apparatus. The exterior bottom and sides of the container are always thermally insulated. The top may be insulated or not depending upon the specific experiment requirements. An experiment mounting plate provides a solid mounting surface for equipment.

Heflex Bioengineering Test

The Heflex Bioengineering Test is not a full-blown experiment, but a preliminary test in support of a later Spacelab experiment in micro-gravity plant growth. The Spacelab Heflex (for Helianthus annus Flight Experiment) depends on dwarf sunflower plants grown to a particular height range. The test flown on STS-3 will investigate the relationship between plant height and initial soil moisture content in a near weightless environment. Shortly before launch, a suitcase-like container will be loaded aboard Columbia containing 72 sealed plant modules varying in soil moisture content from 58 to 80 percent by weight. The container will be stowed in a locker in the crew compartment and removed unopened as soon as possible after flight for evaluation. Principal investigator is Allan H. Brown of the University of Pennsylvania.

Spacelab Module Unveiled at KSC

Vice President George Bush unveiled the flight module of Spacelab, the Space Shuttle's reusable scientific research facility, at Kennedy Space Center, Fla., on Feb. 5. The participation of Vice President Bush in the unveiling of the European-built Spacelab reaffirmed the Reagan Administration's commitment and support of joint U.S.-European scientific ventures in space.

Spacelab, developed and built under the aegis of the European Space Agency (ESA), is Europe's contribution to NASA's Space Transportation System. It arrived in the United States in December, and a second flight version will be delivered in mid-1982.

Spacelab is a flexible laboratory system that features several interchangeable elements that can be put together in various configurations to meet the particular needs of a given flight. The major elements are a habitable module in which scientists can work in a shirt-sleeve environment and platforms called pallets which can be placed in the Shuttle cargo bay behind the module. These pallets will hold instruments requiring direct exposure to space.

Various configurations of these Spacelab elements can be fitted into the Shuttle to meet the needs of any particular mission. The habitable module can be carried alone, or with one or more pallets. The pallets can also be carried into space on a mission that uses no habitable module. Even when no habitable module is carried, the facility is still called Spacelab.

The module comes in two 4-meter (13.1-foot) diameter segments. The "core segment" houses data processing equipment and utilities for both the pressurized module and pallets when flown together. It also has laboratory fixtures such as air-conditioned experiment racks and a work bench. The second section, called the experiment segment, provides more pressurized work space, additional experiment racks and work benches if needed. The core segment can be flown by itself (called the "short module" configuration), or coupled in tandem with the experiment segment (called the "long module" configuration). The short module, which consists of the core segment and two cone-shaped end sections, measures 4.26 m (15.4 ft) in length. When the two segments are assembled, the maximum outside length, including end cones, is 7 m (23 ft).

The pallets are uniform. Each is a u-shaped platform 4 m (13.1 ft) wide and 3 m (10 ft) long. Heavy items, such as telescopes, are attached to reinforced "hard points" on the pallet's main structure. Lightweight payload equipment can be mounted on the aluminum honeycomb panels that cover the inside of the pallet.

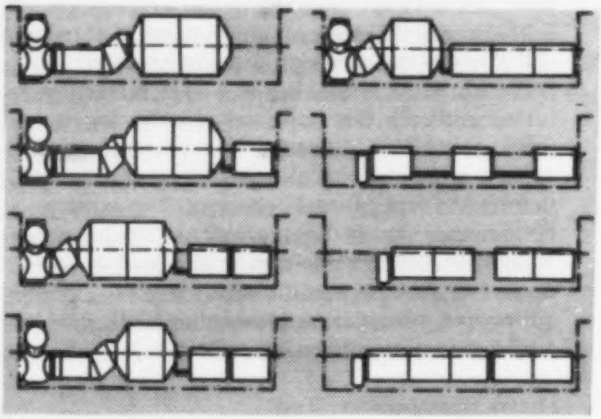
Up to five pallets may be flown on a single mission. When pallets are flown without a habitable module aboard, subsystems needed for equipment operation (which would normally be housed in the core segment of the module) are placed instead in a pressurized cylinder mounted to the front frame of the first pallet. This cylinder is called the "igloo."

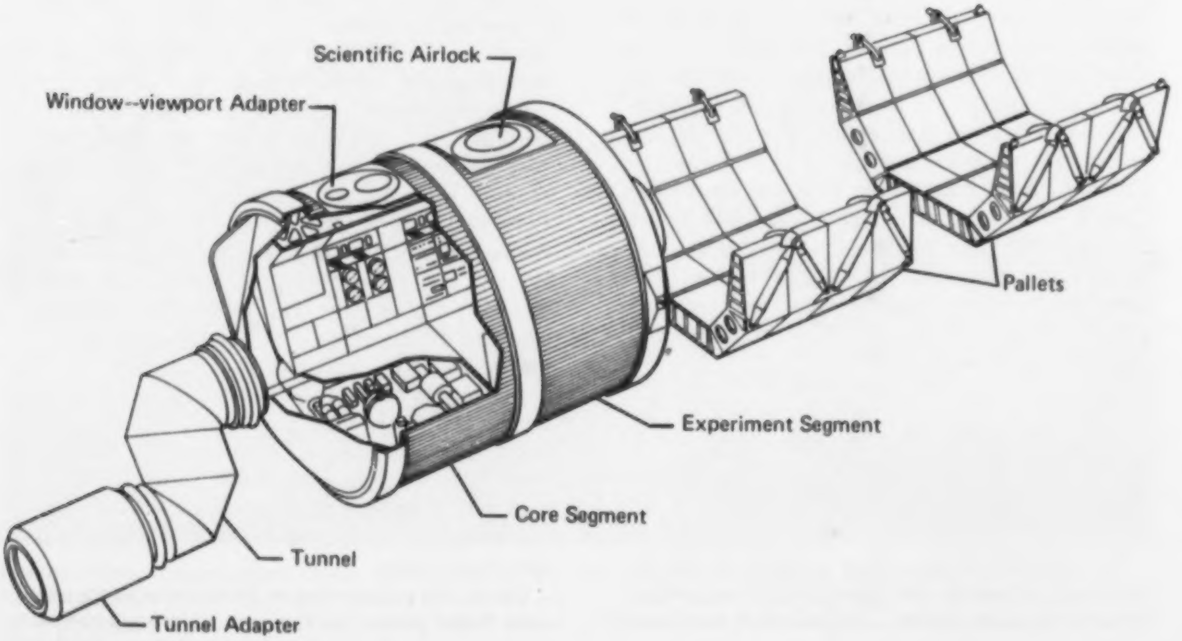
Racks for experiment equipment that goes into the habitable module are also standardized. The 48-centimeter-wide (19-inch) racks can be arranged in single and double assemblies. Normally, the racks and floor are first put together outside the module, checked out as a unit, and then slid into the module where connections are made between the rack-mounted experiment equipment, the subsystems in the core segment, and the primary structure.

Spacelab has other important elements. When a habitable module is flown, an access tunnel about 1 m (3.3 ft) in diameter connects the module with the mid-deck level of the orbiter cabin. The hatch between the cabin and tunnel is left open during a mission, so the Shuttle cabin, tunnel and module all share the same pressure and common air. The tunnel has lighting and handrails to allow easy passage between Spacelab and the Orbiter mid-deck, where the Spacecrew will sleep and take their meals. The length of the tunnel varies with the number of pallets carried behind the habitable module. The more pallets aboard, the further forward the module is carried, hence the shorter the tunnel. Its length ranges from 1.4 m (4.5 ft) to 5.7 m (18.9 ft).

A high quality window-view-port assembly is normally carried in the "ceiling" of either the core segment or experiment segment of the module. A small viewport is permanently mounted in the aft end cone

Spacelab's habitable module and pallets can be configured in several combinations to best support individual mission requirements.





of the module. A scientific airlock may be installed in the overhead area of the experiment segment for use in exposing small instruments to the space environment outside.

The major subsystems of Spacelab include: structure, environment control, electrical power and distribution, command and data management, and common payload support equipment.

The first mission, sponsored jointly and shared equally by NASA and the European Space Agency, is currently scheduled for September 1983. It will feature about 70 separate investigations during seven days in orbit. The Spacelab configuration will consist of the two-segment module and one pallet.

International in nature, Spacelab Mission 1 will have experiments from the United States, Japan, the Netherlands, United Kingdom, Belgium, France, Germany, Italy and Switzerland.

The disciplines represented by these experiments are: atmospheric physics; Earth observations; space plasma physics; materials sciences technology; astronomy; solar physics; and life sciences.

The science crew will consist of two payload specialists, who will operate the experiments with support provided by two mission specialists. Prior to the mission, one American and one European will be selected to actually fly the mission. The others will provide support from the Payload Operations Control Center on the ground. The mission specialists will be astronauts Dr. Owen Garriott and Dr. Robert Parker. The payload specialists selected for Spacelab Mission 1 are:

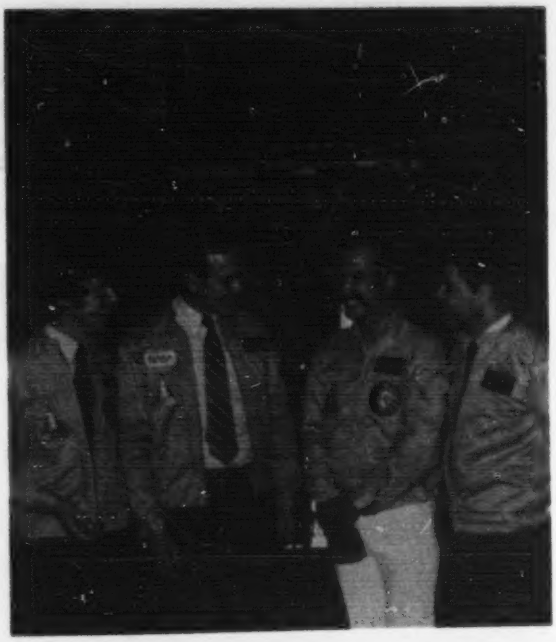
Dr. Michael L. Lampton, a member of the research staff at the Space Sciences Laboratory, University of California at Berkeley. His main fields include astronomy, space physics and optical and electronics engineering.

Dr. Byron K. Lichtenberg of Massachusetts Institute of Technology, who specializes in biomedical engineering.

Dr. Ulf Merbold, staff member at the Max-Planck Institute, Stuttgart, West Germany. His main interests are the study of crystal lattice defects and low-temperature physics.

Dr. Wubbo Ockels, of Groningen University, the Netherlands. He has been involved deeply in nuclear physics experimental investigations.

ESA's prime contractor in the development of Spacelab is the West German firm ERNO Raumfahrttechnik GmbH. Some 50 firms in ESA's 10 participating nations funnel parts to ERNO in Bremen, West Germany, for assembly and integration.



Vice President George Bush taking a tour of the Spacelab hardware in Kennedy Space Center's Operations and Checkout Building. Bush participated in the Spacelab Delivery Ceremony held at Kennedy on Feb. 5. At far left is Ulf Merbold, Spacelab payload specialist, West Germany; second from right, Wubbo Ockels, Spacelab payload specialist, the Netherlands; and at right, Bob Parker, NASA astronaut.

Spacelab is a joint ESA/NASA venture. ESA manages its development with technical support from NASA, while NASA's Marshall Space Flight Center, Huntsville Ala., has prime NASA responsibility for the development in the United States of various flight hardware items such as the transfer tunnel and other ground equipment and facilities to operate the system. Marshall, together with ESA's Spacelab Payload Integration and Coordination in Europe, will manage the first Spacelab mission. Marshall will manage the second and third scientific missions, which are NASA only. The laboratory will be prepared for flight and installed in the Shuttle at Kennedy.

Delivery of the Spacelab to the United States marked a significant step in this program of European-American cooperation in the exploration of space. Under the program, which is costing ESA nearly $1 billion, NASA is receiving at no charge an engineering model and one complete flight version of the laboratory, associated ground support equipment and some computer software. NASA is purchasing a second Spacelab flight unit for approximately $300 million.

Remarks of Vice President George Bush
Spacelab Delivery Ceremony
Kennedy Space Center, Fla.
February 5, 1982

I am very happy to be here with you all today, and I thank you for inviting me to take part in the ceremonies. It seems I turn up at so many Space Shuttle-related events, people are going to start calling me a NASA groupie.

As a matter of fact, I am one. And I hope you keep inviting me back.

I give a lot of speeches these days. This one will be short—you'll no doubt be relieved to hear. I often say, in these speeches, that we're doing our best to bring down the inflation rate, to bring down the interest rates—and that the only thing we want to see going up is the next Space Shuttle.

And now something else will be going up with the Shuttle.

This is a happy day, and an important day. Spacelab, Europe's contribution to the Space Shuttle Program, is an extraordinary engineering achievement. It's also the largest cooperative space project ever undertaken. On behalf of President Reagan and all Americans, I want to congratulate our European partners, especially Dr. Johannes Ortner and Eric Quistgaard, for their fine work.

Spacelab is the fruit of a lot of hard work. Ten member nations of the European Space Agency brought it about. Over two thousand men and women built it. Over fifty European firms participated in the project. Americans can, too, take satisfaction in it. If today can be considered Spacelab's birthday, then there are a great many proud parents celebrating.

You've heard enough about what Spacelab can do—or indeed, you already know enough, since I have a feeling most people here have PhD's in at least one scientific field. Let me just tell you that as a layman, I'm amazed by its potential. Its telescope will look up and out into the outer reaches of space, capturing images of galaxies, of Halley's comet; its cameras will look down on Earth, relaying vital information about crops, pollution, and precious natural resources. In this space laboratory, specialists will work to further our knowledge about vaccines, alloys, pure matter, microwaves . . . and they will try to find a cure for that unique misery of modern age . . . spacesickness.

You all are much more conversant with science than I. So instead, I thought I might offer a comment or two on other, less technical aspects of Spacelab.

Before the first astronauts left the Moon, they left there a plaque that said, "We came in peace for all mankind."

Now man is returning to space once again, this time with all the tools of peace.

And in that connection, I feel very honored today to be able to announce that next flight. The third launch of the Space Shuttle Columbia from Kennedy Space Center has been set for March 22, 1982 at 10:00 a.m.

The crew for that third Shuttle mission is Jack Lousma, Commander, and Gordon Fullerton, Pilot. I know they will continue the unbroken chain of excellence in the performance of their important mission.

Following seven days and three hours in Earth orbit, the Columbia is scheduled to land on the dry lake bed at Edwards Air Force Base, California on March 29.

The knowledge that Spacelab will bring back from its many missions will belong to all mankind.

We are returning to space . . . together, and that is no small achievement. The Space Shuttle and Spacelab represent a bond, not just of transatlantic cooperation and friendship, but of a cooperation and friendship that will extend even beyond the Earth, into the Heavens.

If the Shuttle itself embodies all that is bold and dynamic in the American character, Spacelab symbolizes the unity and determination of free Europe. Together they are a potent symbol, of the interdependence of our nations, and of our partnership.

Let us continue to be partners, in this and in all fields.

And let me take this opportunity to assure you that we intend to continue our international, cooperative programs, just as President Reagan recently reconfirmed the commitment of the United States to a vigorous space program.

"There is beauty in space," said Wernher von Braun, standing on the threshold of the space age in 1958, "and it is orderly . . . everything in space obeys the laws of physics. If you know these laws, and obey them, space will treat you kindly. And don't tell me man doesn't belong out there. Man belongs wherever he wants to go—and he'll do plenty well, when he gets there."

How far we have come in the last quarter century, and how far we'll go in the next. Spacelab is a claim to the truth of von Braun's boast that we belong wherever we want to go . . . and will prove, I am sure that we'll do plenty well when we get there.

Vice President Bush inside Spacelab in Kennedy's Operations and Checkout Building where the ESA-built orbital laboratory was dedicated Feb. 5. At left is Spacelab mission specialist Ulf Merbold, West Germany; at right is NASA astronaut Owen K. Garriott.

New Saturnian Satellites Discovered

Four, and possibly as many as six, new satellites of Saturn have been found, using data from the Voyager 2 encounter with the planet in August 1981. The discoveries bring the number of known Saturnian satellites to between 21 and 23. The two "possible" satellites were seen in only one observation each, so their orbits are not yet confirmed.

The innermost satellite found by Dr. Stephen P. Synnott of NASA's Jet Propulsion Laboratory, Pasadena, Calif., moves at about the same orbital distance from Saturn as the already-known satellite, Mimas. The object was originally suggested by data from charged-particle instruments aboard Voyager 2. Synnott and Jet Propulsion Laboratory scientist Richard Terrile found the satellite.

A third (and possibly fourth) companion of the satellite Tethys appears to move in what Synnott calls a "horseshoe" orbit. Synnott says that he is sure an object is there, but he is not certain yet, because of resolution limits in the photos, whether it is one or two objects. Satellites in horseshoe orbits trade orbits as they approach each other.

Another satellite was found by Synnott at a point about 60 degrees ahead of the satellite Dione. That is the second found in that region. The first was discovered in Earth-based observations in 1980.

Synnott found yet another satellite about 350,000 kilometers (217,000 miles) from Saturn, between the orbits of Tethys and Dione. It circles Saturn once in 2.44 days.

Synnott's final observation, a faint streak in a Voyager 2 photo, indicates a satellite (the "possible sixth") may exist about 470,000 km (292,000 mi.) from Saturn, between the orbits of Dione and Rhea. Its period of revolution would be, Synnott calculates, 3.8 days.

The object that shares the orbit of Mimas is about 10 km (6 mi.) in diameter. All the others are about 15 to 20 km (9 to 12 mi.) in diameter.

Two Voyager spacecraft were launched in 1977, flew by Jupiter in 1979 and Saturn in 1980 and 1981. Before these encounters, Jupiter was known to have 13 to 14 satellites. Voyager raised the total for Jupiter to at least 16.

Saturn was known to have 10 satellites, but the two Voyagers now have found at least 11 to 13 additional ones.

Voyager 2's next planetary encounter will be with Uranus in 1986. The Voyager project is managed for NASA by the Jet Propulsion Laboratory.

New Venus Discoveries Reported at International Conference

Dramatic new finds about Venus, the Earth's twin planet, were reported at the NASA-University of Arizona-sponsored first International Conference of the Venus Environment, held in Palo Alto, Calif., in November. Several hundred scientists from the United States and other countries attended the Venus conference. Much of the new information comes from data returned by the six Pioneer spacecraft and their 30 experiments. The Pioneers are managed by NASA's Ames Research Center, Mountain View, Calif.

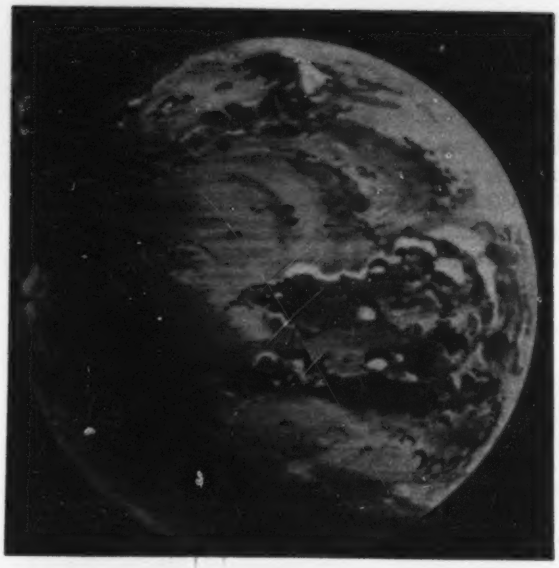
New findings include evidence for two major, currently active volcanic areas on the planet; the probability that these areas are the principal vents for the planet's internal heat; quantified findings that Venus has a thicker crust than Earth and is a "one plate" planet with little plate tectonics; and complete, self-consistent models of Venus' cloud system and greenhouse effect.

Considerable progress has also been made in understanding overall atmosphere circulation (with implications for Earth); and there is strong new evidence for former Venusian oceans on the scale of the Earth's oceans.

Much of the significance of the Venus findings lies in the fact that the Earth and Venus appear to be almost identical copies of each other. Scientists believe the Earth would become a virtual Venus if you stopped its rotation, removed the Moon, and moved our planet slightly closer to the Sun. Therefore, studies of Venus provide a variety of insights into Earth mechanisms.

New Venus discoveries included:

- Apparently there are two major volcanic regions on Venus: Beta Regio and the Scorpion Tail of Aphrodite Terra, largest continent-like upland region on the planet. There is evidence for continuous and current volcanic activity at both places.
- Detailed analysis of Venus' global topography and detailed comparisons with global crustal density (derived from gravity data), show that Venus apparently has a thicker crust than Earth and is a "one plate" planet. Substantial evidence indicates that its crust is not broken into many continent-bearing plates, floating on the liquid interior, as the Earth's crust is.
- Because of its thick, planet-wrapping crust, most of Venus' interior heat appears to come out in its two volcanic regions, unlike Earth. Earth vents its



Artist's concept of Venus' surface showing the planet's three continental-sized highland regions – Aphrodite Terra (foreground), Ishtar Terra (top), and Beta Regio (left) based on topography measurements made by the Pioneer spacecraft.

heat at many points, especially at the constantly expanding mid-ocean ridges. Concentration of Venus' lightning over just two volcanic regions suggests fairly frequent current volcanic activity in both places.

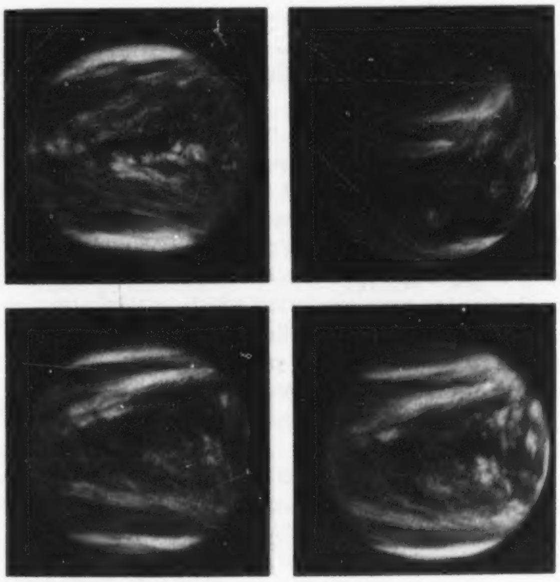
- Though Venus' continents appear not to drift around on crustal plates as Earth's do, crustal density measurements suggest local uplifting of large regions.

This is probably due to up-flowing convective plumes, resulting from circulation of interior magma. The most prominent of these are Aphrodite Terra and Ishtar Terra. Vertical motion of the crust also is suggested by the several deep rift valleys; one, the lowest point on the planet, is at the Scorpion Tail of Aphrodite.

- Beta Regio, a region larger than the Hawaii-Midway chain, appears to be a huge double-shield volcanic construct and is apparently the most active region on the planet. This is shown by variations in crustal density, apparent old lava flows and the region's 6,100-meter (20,000-foot) height and huge size. Beta is believed to sit over a powerful, upflowing convective plume, deep in Venus' interior magma.

- The new topography data show other smaller volcanoes and one crustal rift 1,500 kilometers (810 miles) long.
- Venus' clouds are "upside down." There's a smog layer on top 15 km (8 mi.) deep, and Earth-like condensation clouds (made of sulfuric acid droplets) below 57 km (31 mi.) extending down to 48 km (26 mi.). These condensation clouds are patchy and vary in density. They produce drizzle but seldom hard rain, and in general are only 10 percent as thick as comparable Earth clouds. Scientists also have now charted and quantified the basic cycle of chemical reactions in the clouds.
- Unlike Earth, which absorbs most solar heat on its surface, Venus absorbs most solar heat in its clouds. In the cloud layer is a single convective circulation cell which carries heat from equator to pole. Earth has three linked major circulation cells transporting heat between equator and poles.
- Venus' cloud region is also a shell of high-speed winds which englobes the planet. Above this wind layer, the atmosphere is almost dead calm. There are two explanations for these high-speed winds on a planet with no rotation.

Both propose wave (eddy)-pumping of the enormous momentum of the planet's dense lower at-



Ultraviolet photos of Venus' clouds selected from 1,000 views of the planet by the Pioneer Venus orbiter spacecraft. Those shown were taken between May 2 and 4, 1980 and cover a period of 38 hours; the planet's clouds circle Venus completely once every 4 days.

mosphere to higher altitudes where the momentum remains. One of these proposed mechanisms involves large horizontal eddies; the other, tidal effects as the lighted hemisphere moves slowly around the planet. Weather theoreticians agree that wave pumping mechanisms are critical to understanding Earth's weather; these mechanisms are not well understood on any planet; and that they have been brought into prominence by recent Venus work.

- Venus appears to have had an ocean and lost it to space. During the solar system's early history (when scientists believe the Sun was 30 percent less hot) Venus' atmosphere and environment could have been Earth-like. Strong evidence for this lost water remains today in the definitive measurement of the ratio of deuterium to hydrogen. (There is 100 times as much deuterium relative to hydrogen on Venus as on Earth. This measurement was found for the first time in the Pioneer data during the recent Venus conference.) With water abundant, the planet may perhaps have sustained life during the early years of solar system's history. When the runway greenhouse effect began, it wiped out most existing phenomena on the planet and replaced them with today's furnace-like environment.

Inspector General Activities

At the request of NASA management officials, NASA's Offfice of the Inspector General initiated efforts to review instances of telephone abuse at a field center. Review of telephone charges identified a NASA employee as having placed over 80 telephone calls to the employee's residence during which time conversations were conducted which totalled approximately 20 hours. The NASA employee probably expected to be billed for the cost of the calls, which did occur. What was not expected was that the employee was charged annual leave for the time spent on the telephone.

As a part of the OIG's comprehensive audit efforts, it was determined that certain policies and procedures used by a NASA contractor for accounting were not adequate to assure proper classification of labor costs. A more in-depth review was scheduled due to the absence of system controls. Mischarging by the contractor in the amount of $3.3 million to the U.S. Government was discovered. Ten percent of the overcharge, $330,000, was directly related to NASA.

The Office of Inspector General urges you to continue your efforts in meeting the challenge of improving NASA programs. Suggestions for eliminating waste and mismanagement are welcome. Identities can be confidential. A 24-hour answering service is available in the Washington, D.C. area on 755-3402 or call (800) 424-9183 (toll-free for all other areas). Please send written suggestions to: NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, D.C. 20024.

Awaiting Launch—Space Shuttle Columbia at Kennedy Space Center's Launch Pad 39A is readied for its third orbital flight; launch is scheduled for March 22.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
Columbia (OV-102)	March 22	KSC	OSS-1
Columbia (OV-102)	July	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-B, Telesat-E

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
• Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Insat 1A	April 8	Delta	ESMC	India communications. Reimbursable.
NOAA-E/SAR	June	Atlas-73E	WSMC	NOAA/SAR weather. Reimbursable.
Navy 21	June	Scout	WSMC	DOD transit. Reimbursable. Callup.
Intelsat V-E	July	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Landsat-D	July	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August	Delta	ESMC	Canada communications. Reimbursable.
Westar-V	September	Delta	ESMC	Western Union communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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*Successful launch

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Hubert C. Vykukal and Bruce Webbon, NASA/ARC	Pressure suit joint analyzer	4,311,055	ARC
Marnell Smith, Victor, W. Katvala and Ernest E. Porter, NASA/ARC	Spray coating apparatus having a rotatable work-piece holder	4,312,292	ARC
E. Thomas Freeman, Charles W. Stump and Francis R. Dreisbach, NASA/LaRC	Film advance indicator	4,311,378	LaRC
Russell T. Crowell, NASA/KSC	System and method for refurbishing & processing parachutes	4,313,291	KSC
Wendell D. Chase, NASA/Ames	Environmental fog/rain visual display system for aircraft	4,313,726	ARC
Gordon F. Lund, National Research Council, Washington, D.C.	Pocket ECG electrode	4,313,433	ARC
John D. Buckley, Robert J. Swaim, Robert L. Fox, NASA/LaRC	One-step dual purpose joining technique	4,313,777	LaRC
James M. Kendall, Jr., Caltech/JPL	Method of forming spheres in a forcefree drop tower	4,313,745	NRO/JPL
Philip A. Studer, NASA/GSFC	Linear magnetic motor/generator	4,315,197	GSFC
Daniel D. Lawson and Gene R. Peterson, Caltech/JPL	Thermochemical generation of hydrogen	4,314,984	NRO/JPL
Denis J. Connolly, NASA/LeRC	Coupled cavity traveling wave tube with velocity tapering	4,315,194	LeRC
Haynes Ellis, Jr., Rockwell International Corp.	Complementary cross-slot phased array antenna	4,315,266	JSC
Reinhold H. Kratzer, Kazimiera J.L. Paciorek . Thomas I. Ito, Ultrasystems Inc., Irvine, Calif., and Robert W. Rosser, NASA/ARC	Preparation of perfluorinated 1,2,4-oxadiazoles	4,316,035	ARC
Thomas Vranas, NASA/LaRC	Hot foil transducer skin friction sensor	4,317,102	LaRC

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Police Communications

When the Oklahoma City Police Department needed a computerized communication system, they turned to NASA technology for assistance—specifically that developed for the Mission Control Center at NASA's Johnson Space Center, Houston.*

Developed in 1960, Mission Control provided entirely new, specially-designed communications, computing and display systems which have been updated over the years. In designing the facility, NASA paid particular attention to the human factors involved in ground management of long duration flights—for example, selection and training of control center personnel; most effective informational displays; and special lighting to reduce controller fatigue and eyestrain.

For the Oklahoma City police communications needs, officials from NASA's Johnson Space Center furnished information on lighting and other fatigue-reducing measures and provided specifications for equipment and design layouts. NASA personnel were particularly helpful in advising how to avoid communications bottlenecks associated with simultaneous handling of telephone, radio and interoffice transmissions.

The use of already-developed NASA technology resulted in a cost savings for the Department in the design and engineering elements of their police communications system.

For each major duty in the Oklahoma City Police Department's communications system there is a computer display console—for each of the four dispatch coordinators and for the telecommunications coordinator, who handles inter-office calls from Department office. Public calls for assistance are received by telephone clerks who have such a terminal at their fingertips. Radio messages—incoming calls and dispatch transmissions—are handled separately by a radio communications coordinator who also is equipped with an individual console.

NASA

National Aeronautics and
Space Administration

For the benefit of all . .

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*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of such technology.

*U.S.GOVERNMENT PRINTING OFFICE : 1982 0-861-563/109

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NASA Activities

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Administration

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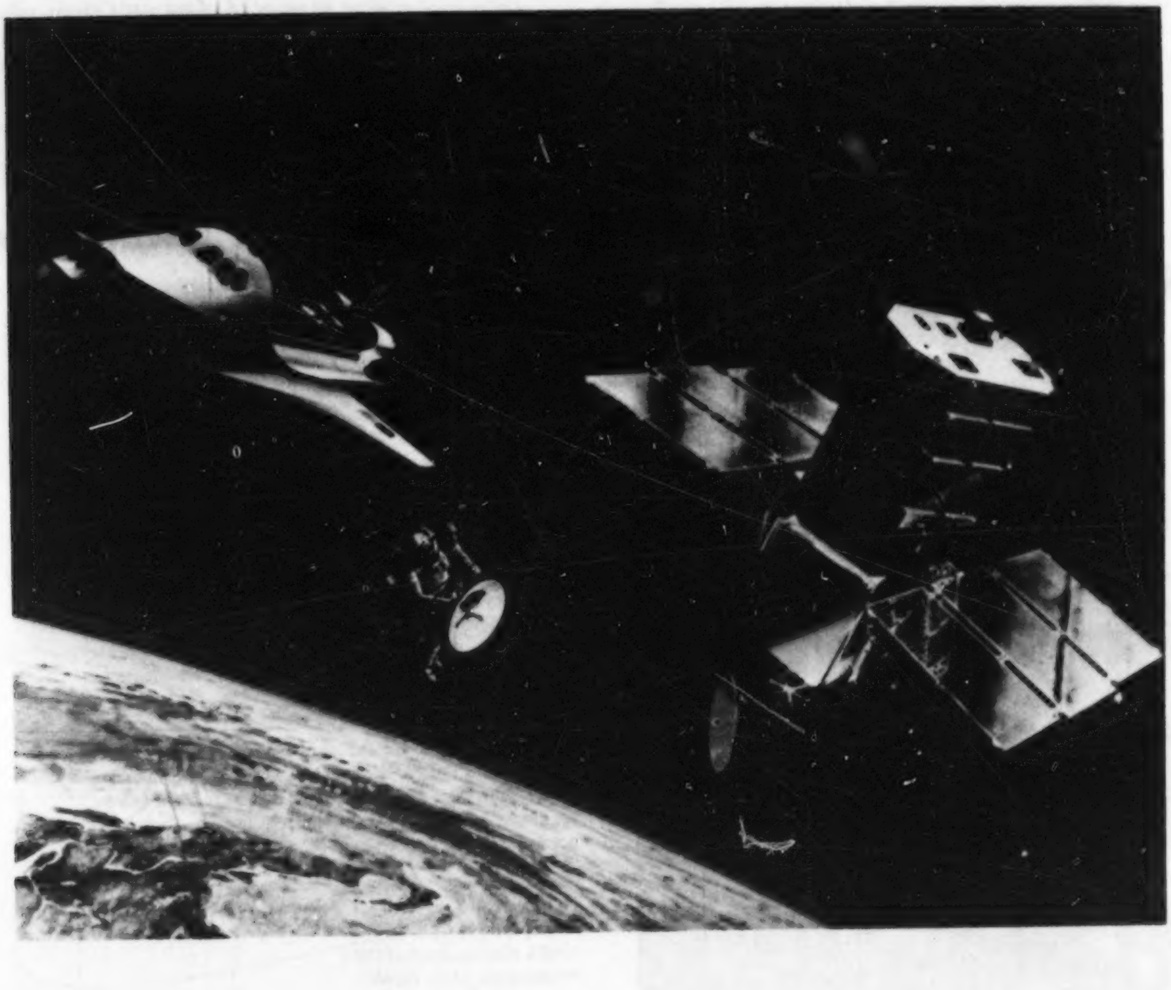

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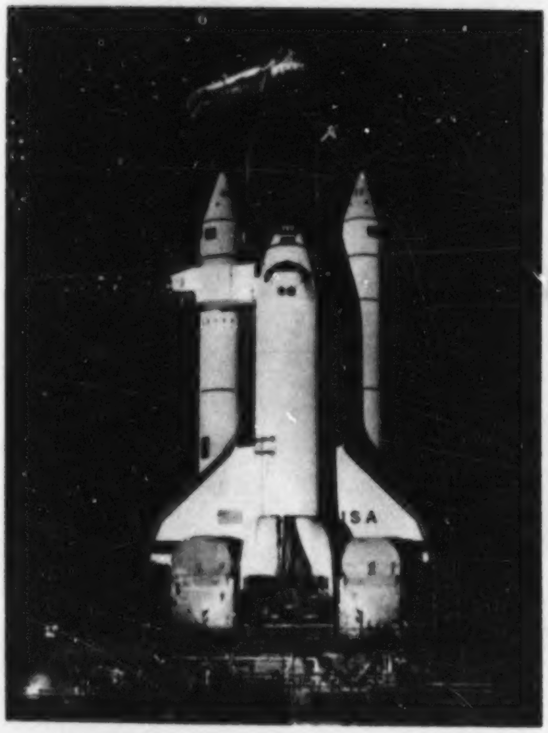
About the Cover

Artist concept of NASA's proposed Solar Maximum Repair Mission. On a future Shuttle flight, astronauts would rendezvous on-orbit with the Solar Max satellite, retrieve it, perform repairs within the Shuttle cargo bay and then redeploy the satellite to continue its observation and data collection on the Sun's solar flare activity. If approved, this mission would be manifested for early 1984.

Below, the key to such a mission, the Space Shuttle, awaits its third launch from Kennedy Space Center on March 22. Photo coverage of the Columbia's third successful flight in the orbital test flight series will appear in the May edition of *NASA Activities.*



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Solar Maximum Repair Mission

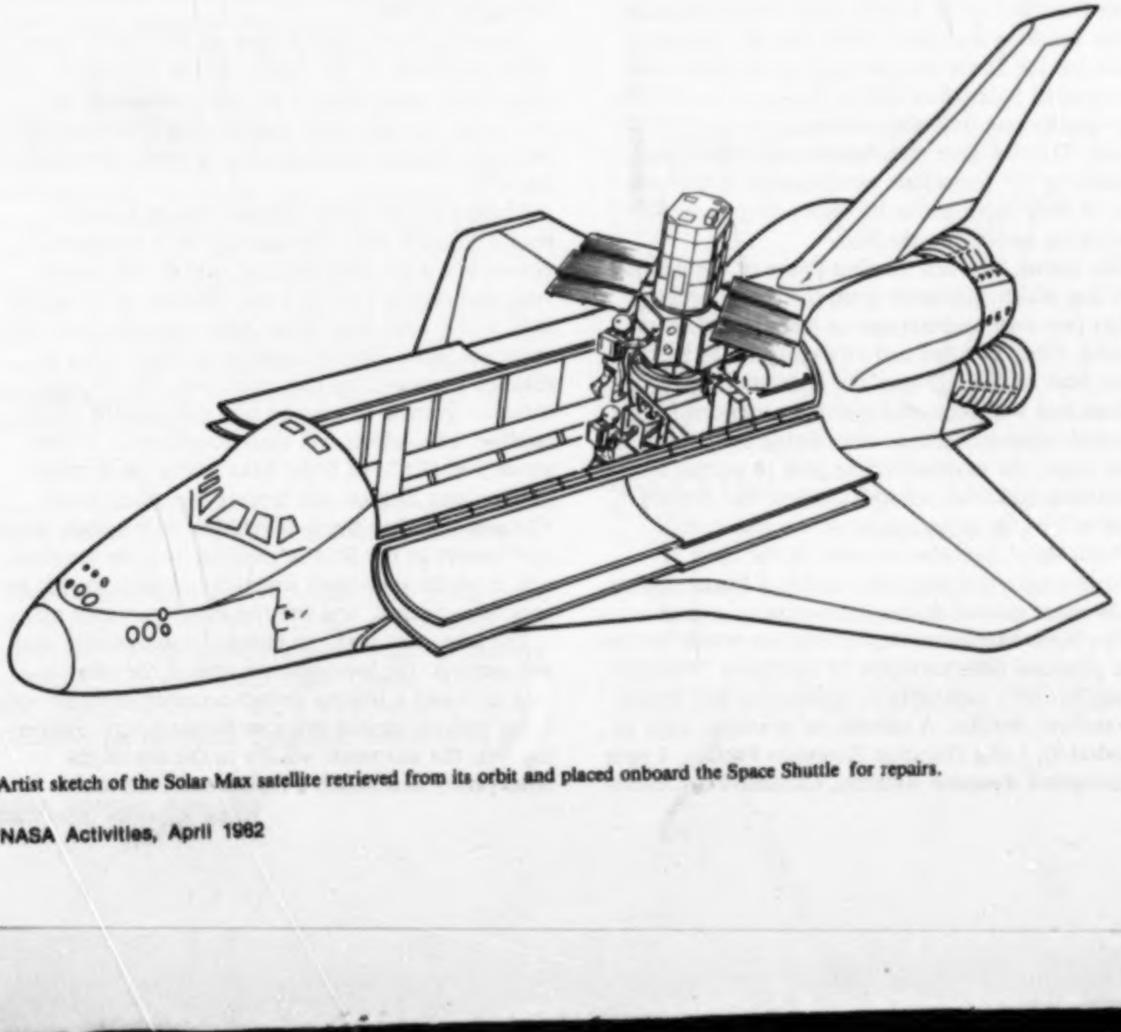
NASA is seeking budget approval to conduct a rendezvous and repair of the Solar Maximum Mission observatory at the end of four years of on-orbit operation using the Space Transportation System and the multimission modular spacecraft flight support system. The mission would be tentatively manifested for early 1984.

The Solar Maximum Mission payload consisted of seven instruments whose prime objective was the coordinated observation of solar flares during the current period of high solar activity. Solar Max, which was launched on a Delta expendable launch vehicle on Feb. 14, 1980, was declared a success after more than seven months of satisfactory scientific observations during which the scientific model of the dynamics of the Sun was greatly enhanced.

Around 10 months after launch, underrated fuses in the attitude control subsystem module shorted out on three of four attitude control momentum storage wheels which caused loss of the precision stabilization. Since that time, the spacecraft has been placed in a slow spin using a magnetic control mode which permits continued operation of three instruments while coarsely pointing at the Sun.

The primary objective of the Solar Maximum Repair Mission is to conduct a technological demonstration of the Space Transportation System's capability for on-orbit rendezvous, servicing, checkout, and deployment of a free-flyer satellite while at the same time restoring the fine-pointing capability of the Solar Max observatory and thus the capability for operation of the science instruments. The pointing repair will be achieved by on-orbit replacement of the attitude control subsystem module with a Landsat-D/Solar Max flight spare. This capability is provided by the modular design of the multimission modular spacecraft which is the first application of this technique for free-flyer/Space Transportation System interface compatibility. Replacement of the attitude control subsystem module by extravehicular activity will restore full scientific operation to six out of seven instruments in the Solar Max payload.

A secondary objective is to eliminate operating instrument anomalies by extravehicular activity installation of a plasma baffle (deflection cover) over the soft X-ray polychromator propane exhaust port,



Artist sketch of the Solar Max satellite retrieved from its orbit and placed onboard the Space Shuttle for repairs.

replacement of the hard X-ray imaging spectrometer, front aperture thermal blanket and, if time permits, replacement of the failed coronograph/polarimeter main electronics box. This would return the entire Solar Max observatory to full operation.

Before the attitude control system on Solar Max malfunctioned, many unique observations of solar flares had been made and a number of these observations have provided new insights into the physics of flares.

Investigators from each of the Solar Max instrument teams currently are working in collaboration with NASA's Goddard Space Flight Center which operates the Solar Max observatory to understand the full significance of the data thus far collected. Approximately 30 papers have been published or have been submitted for publication on the Solar Max results. Three of the seven instruments continue to collect significant data: the solar constant, gamma-ray, and hard X-ray burst experiments.

As impressive as the Solar Max results have been thus far, one must realize that the investigators were still not yet using the full observing power of the mission when the attitude control subsystem malfunctioned. This untapped potential could be fully realized with the renewed mission that would result from the repair activity. Following activation of the Tracking and Data Relay Satellite System, scheduled for Space Shuttle launches six and eight, the repaired Solar Max will be capable of supplying high-quality real-time solar observations on Sunside passes. This will give investigators unprecedented capabilities for immediate participation in the conduct of their experiments by responding to rapidly developing activity on the Sun.

The hiatus, between the first phase of the mission and that which will result from the repair activity, offers two major advantages to the scientific community. First, detailed understanding of the early Solar Max results will spur the generation of highly refined and well focused observing programs for the renewed mission. Second, considering the time in the solar cycle, the payload will be able to pursue several interesting quiet-Sun scientific objectives. Among these will be the investigation of coronal holes, monitoring of the solar constant as the cycle approaches minimum and monitoring of the evolution of the solar corona during the minimum period.

The Solar Maximum Repair Mission would be the first practical demonstration of the Space Transportation System's capability to rendezvous and service a free-flyer satellite. A number of missions, such as Landsat-D, Long Duration Exposure Facility, Upper Atmosphere Research Satellite, Gamma-Ray Observatory and Space Telescope, have considered retrieval and/or servicing for the purpose of refurbishment and reuse.

An assessment of long-term space environmental effects on the recovered hardware will be performed and the Solar Max attitude control subsystem module will be reworked to support the requirements of the Landsat-D program.

The magnitude of rework and associated cost of refurbishment will help establish guidelines in planning future reuse of free-flyer spacecraft parts and the flight support system by other missions. The lessons learned in the course of the mission and in postlanding analyses will help generate improved techniques for the design of future Shuttle-compatible spacecraft.

The baseline Solar Maximum Repair Mission is planned as a five-day operation with the Space Shuttle employing direct injection to the operational attitude. The rendezvous with the Solar Max observatory will be at an altitude of 490 ± 20 kilometers (265 ± 11 nautical miles) and inclination of 28.5 degrees. The mission, which may be conducted as a shared mission if another suitable payload is available for manifesting in this timeframe, would be launched from NASA's Kennedy Space Center, Fla., during early 1984.

The orbiter will carry a crew of four and a repair cargo consisting of the flight support system, a replacement multimission modular spacecraft attitude control subsystem module, experiment repair parts, module service tools, and manned maneuvering unit.

Phasing of the Space Transportation System launch window and subsequent orbital maneuvering system burns are such that the orbiter will rendezvous and station keep at a safe distance of about 90 meters (300 feet) from Solar Max. An astronaut will approach Solar Max by untethered flight using a manned maneuvering unit equipped with a special trunnion grapple to capture and stabilize the satellite. The orbiter will then maneuver to within about 9 m (30 ft) of Solar Max where the Remote Manipulator System will capture the observatory. The arm will then berth Solar Max to the flight support system in the Shuttle payload bay, the multimission modular spacecraft umbilical connectors will be remotely engaged, and the spacecraft powered off.

The astronaut with the manned maneuvering unit will move to the location over one of the solar arrays to install a plasma deflection cover over the soft X-ray polychromator propane exhaust port. Following this, the astronaut will fly to the top of the observatory and install a replacement thermal blanket over the hard X-ray imaging spectrometer instrument collimator. The astronaut will then stow the manned maneuvering unit and join a companion to exchange the attitude control subsystem module. They will be aided by such items as manipulator foot restraints, portable foot restraints and module service tools.

The final repair operation will consist of removing and replacing the main electronics box of the coronograph/polarimeter and the panel on which it is mounted. The same major extravehicular activity service aids will be used. This will conclude extravehicular activities.

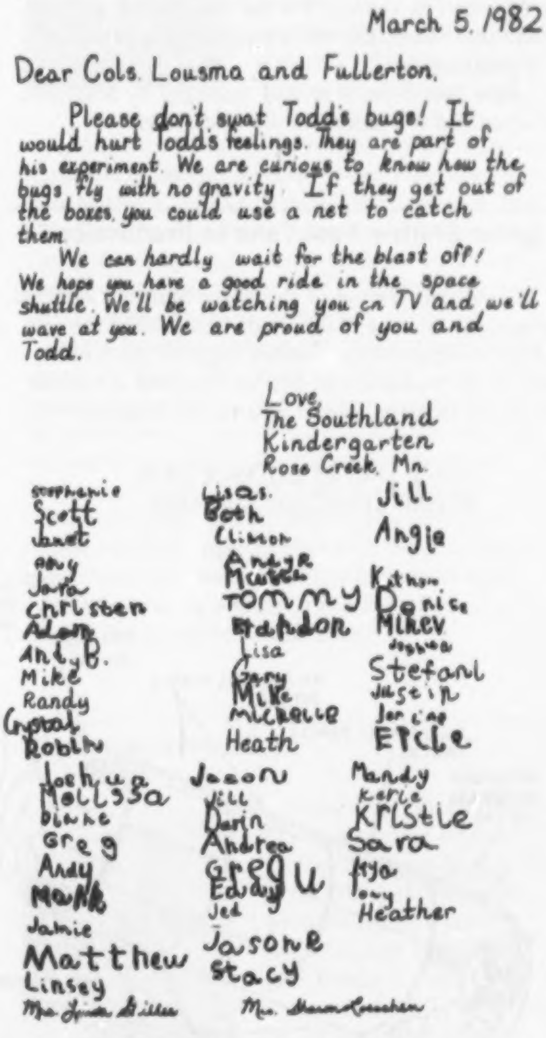
The crew will reactivate the spacecraft from the aft flight deck. A functional checkout of the Solar Maximum Mission will be performed remotely from the Goddard Space Flight Center Solar Maximum Mission Project Operations Control Center. If sufficient orbital maneuvering system propellant remains, the orbiter will reboost the Solar Max to its initial 575 kilometers (310 nautical miles) operational altitude to provide for extended operations. The Remote Manipulator System will then be used to redeploy the Solar Max observatory. Consideration is being given to deployment of the Solar Max's tracking and data relay satellite system high-gain antenna system either just prior to or following the observatory redeployment. The orbiter will then back away from Solar Max, prepare for deorbit, and land at Kennedy Space Center, Fla.

After landing, the flight support system, coronograph/polarimeter main electronics box, and retrieved attitude control subsystem module will be removed from the orbiter and transported to a hangar for inspection. The attitude control subsystem module will then be returned to the module contractor for testing and refurbishment as a Landsat-D spare. This will allow the first hands-on detailed engineering assessment of the effects of extended spaceflight on satellite hardware. The flight support system will be placed in storage until required for the next mission.

ESA Solar Cell Arrays Tested at Marshall

A 14-month-long test of the electrical performance of the solar cells that make up the solar arrays (antennas) for the Space Telescope began in January at NASA's Marshall Space Flight Center, Huntsville, Ala. ESA is furnishing NASA with the Solar Array Assembly for the Space Telescope. Seventy-two cells will be exposed to the equivalent of five years of thermal cycling of +100 to −100 degrees Celsius in the Center's test laboratory thermal vacuum chamber. The cycling represents the extreme range of temperatures the arrays will experience as they move between the Earth's shadow and sunlight.

During the tests, the solar cells, measuring only 20×40 millimeters each, will be subjected to 30,000



March 5, 1982

Dear Cols. Lousma and Fullerton,

Please don't swat Todd's bugs! It would hurt Todd's feelings. They are part of his experiment. We are curious to know how the bugs fly with no gravity. If they get out of the boxes, you could use a net to catch them.

We can hardly wait for the blast off! We hope you have a good ride in the space shuttle. We'll be watching you on TV and we'll wave at you. We are proud of you and Todd.

Love,
The Southland
Kindergarten
Rose Creek, Mn.

Stephanie
Scott
Janet
Amy
Jara
Christen
Adam
Andy B.
Mike
Randy
Crystal
Robin
Joshua
Melissa
Diane
Greg
Andy
Mark
Jamie
Matthew
Linsey
Mrs. Linda Gilles

Lisa S.
Beth
Clinton
Andy R.
[illegible]
Tommy
Brandon
Lisa
Gary
Mike
Michelle
Heath
Jason
Jill
Darin
Andrea
Greg U
Eddy
Jed
Jasone
Stacy
Mrs. [illegible]

Jill
Angie
[illegible]
Denise
Mikey
Joshua
Stefani
Justin
[illegible]
Ercle
Mandy
Karie
Kristie
Sara
[illegible]
Tony
Heather

Bugs Have Feeling Too—The third flight of the Space Shuttle carried an experiment designed by Minnesota high school student Todd Nelson to test the effects of weightlessness on three types of insects. This letter, sent from an elementary school in Todd's school district, was in response to a joke made by the Shuttle prime crew about Todd's experiment during a pre-mission press conference.

cycles of heating and cooling. The cycles are equivalent to the number of cycles to be experienced by an array in its design life of five years.

The test of the cells is also designed to study the weld integrity of the cells in the flight configuration. There are 48,760 cells in both arrays, one on each side of the Space Telescope, that will be extended to provide electrical power for the Telescope after it is deployed in space by the Space Shuttle.

Jean Claude LaRue of ESA brought the samples to Marshall in January for the test startup and will make periodic return visits during the duration of the program.

Space Telescope, a project managed by Marshall, is scheduled for launch in the mid 1980s.

Lighter Shuttle Fuel Tank in Production

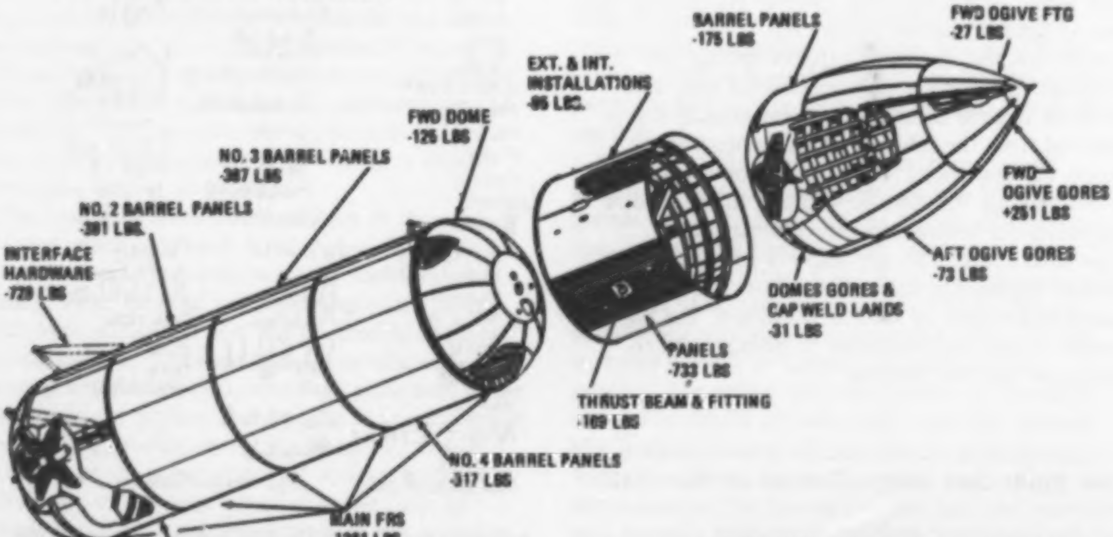
A modified version of the Space Shuttle's external propellant tank—6,000 pounds lighter than the one which was part of the maiden flight of the Columbia—is in production at Martin Marietta Aerospace, Michoud Division, New Orleans, La. Because of its lighter weight, the modified tank will increase the Shuttle's payload-carrying capability by about the same amount.

Since the external tank is the only major nonreusable element of the Shuttle, one tank must be made for each launch. The external tank which was part of the maiden flight of the Space Shuttle Columbia weighed about 77,000 pounds, more than 1,000 pounds less than the NASA-specified weight limit. The second weighed even 200 pounds less. Each of the new lighter weight external tanks will weigh about 71,000 pounds, for a trim three-ton reduction.

The Michoud Division of Martin Marietta Aerospace designs and assembles the giant tanks for NASA in New Orleans and has been working on the lighter weight tank project for two years.

"In 1979, we began working with NASA to trim 6,000 pounds from the tank's weight," said William Barrett, manager of Martin Marietta's work on the lightweight tank. "Actually, with most of the engineering work done and fabrication started on the first four lightweight tanks, we are currently predicting a 6,400-pound reduction, leaving a 400-pound margin for contingencies."

SPACE SHUTTLE EXTERNAL TANK
WEIGHT REDUCTION SUMMARY


BARREL PANELS
-175 LBS
FWD OGIVE FTG
-27 LBS
EXT. & INT.
INSTALLATIONS
-95 LBS.
FWD DOME
-125 LBS
NO. 3 BARREL PANELS
-387 LBS
NO. 2 BARREL PANELS
-391 LBS.
INTERFACE
HARDWARE
-729 LBS
FWD
OGIVE GORES
+251 LBS
AFT OGIVE GORES
-73 LBS
DOMES GORES &
CAP WELD LANDS
-31 LBS
PANELS
-733 LBS
THRUST BEAM & FITTING
-109 LBS
NO. 4 BARREL PANELS
-317 LBS
MAIN FRS
-1381 LBS
AFT
DOME
-12 LBS
NO.1 BARREL PANELS
-650 LBS

STRUCTURAL SYSTEM (ABOVE)	5,053 LBS
THERMAL PROTECTION SYSTEM	991 LBS
PROPULSION & MECHANICAL SYSTEMS	335 LBS
RANGE SAFETY SYSTEM	27 LBS
TOTAL WEIGHT REDUCTION	6,406 LBS

The first four of the so-called lightweight tanks are in various stages of production. The first lightweight tank will be delivered in September 1982 and will be used for the sixth Space Shuttle mission.

"We have used several methods to trim the 6,000 pounds," Barrett said. "One was to make design changes as a result of the information obtained from our very successful structural tests." These changes include the elimination of selected stringers, using fewer ring stiffeners and modifying major frames in the liquid hydrogen tank.

Some fabrication techniques have been changed. For example, dome caps on the first tanks were chemically milled on only one side. Now the caps will be milled on both sides to reduce thickness and weight—without sacrificing the required strength.

"We also changed some materials to take advantage of recent developments in the metals field," Barrett added. "For example, we've reduced the weight of the aft solid rocket booster attachments on the lightweight tanks by making them out of a stronger and a less expensive titanium alloy."

Operational considerations and test data also allowed engineers to eliminate an anti-geyser line used in the liquid oxygen fill system and to relocate the hydrogen pressurization line. The result was a weight reduction of several hundred pounds and a cost reduction.

Although most of the tank's alterations will not be apparent to casual observers, one change is already obvious: six hundred pounds of white latex paint was missing from the tank's surface for the third flight of the Columbia in March. After analyzing data from the first Shuttle mission, NASA and Martin Marietta engineers determined that the external tank's thermal protection system would adequately protect the tank without the paint.

Martin Marietta engineers are evaluating additional weight saving measures which may be implemented in the future. After analyzing information received during the Shuttle's test flights, they may be able to eliminate 1,000 pounds by removing a large slosh baffle from the liquid oxygen tank. Cable trays which now run nearly the length of the tank may be eliminated if electrical cabling is routed through the tank's interior. Lighter weight composite materials could also be substituted for some heavier metal parts. These changes may be made if they can result in cost as well as weight savings.

Martin Marietta builds the external tanks under contract to NASA's Marshall Space Flight Center, Huntsville, Ala.

Astronaut Kerwin Appointed as NASA Representative in Australia

Astronaut Dr. Joseph P. Kerwin has been appointed by NASA to assume duties as the agency's Senior Scientific Representative in Australia effective this month. Upon conclusion of this two-year assignment, Kerwin will return to the Astronaut Office at the Johnson Space Center, Houston.

Kerwin will report to Robert E. Smylie, NASA Associate Administrator for Space Tracking and Data Systems, and will act as liaison between that office and Australia's Department of Science and Technology. He succeeds H. William Wood who has been appointed to the post of director of the Network Systems Division in Smylie's office.

NASA has had a representative in Australia for almost 20 years. Two NASA tracking stations—at Yarragadee and Orroral Valley—support Space Shuttle operations by providing voice contact and data acquisition and relay. Another tracking station near Canberra is used to track deep space probes.

Kerwin's responsibility will be to coordinate NASA tracking requirements with the Australian government and assure its awareness of NASA's plans in space, as well as to facilitate a productive climate for scientific cooperation.

Slayton Leaves NASA

Donald K. "Deke" Slayton, 58, manager for orbital flight test in the Space Shuttle Program Office at the NASA Johnson Space Center, Houston, left NASA in March after 23 years with the space agency. Slayton is the last of the original seven astronauts still with NASA who were selected in 1958 for Project Mercury. Slayton retired from NASA in February 1981, but stayed on the job on a temporary appointment as a rehired annuitant.

He will serve as a consultant to Aerospace Corp. of El Segundo, Calif., and to Space Sciences, Inc., of Houston, from a Clear Lake-area office.

Slayton said of his two decades with the space program: "There's nothing I'd rather have been doing. I really looked forward to getting up each morning. But this new phase of my career looks like it also should lead to constructive, enjoyable work."

Grounded from space flight in August 1959 because of a suspected heart condition, Slayton later was approved for flight and was part of the American crew in the July 1975 U.S.-U.S.S.R. Apollo Soyuz joint space rendezvous and docking mission.

While grounded, Slayton served as head of the Astronaut Office and Director of Flight Crew Operations at the Space Center. Slayton resigned from the Air Force in 1963 and joined NASA. He was manager for the approach and landing tests with the Space Shuttle orbiter Enterprise from 1975 to 1977. In 1977 he was named to manage the four-mission orbital flight test program with orbiter Columbia to bring the Shuttle Space Transportation System to operational readiness.

Slayton joined the Air Force in 1942 as an aviation cadet and flew 56 combat missions in Europe and seven over Japan as a B-25 bomber pilot. He was a test pilot at the Air Force Test Pilot School at Edwards Air Force Base, Calif., when he was selected as a Mercury astronaut. Slayton has logged more than 7,000 hours flying time, most of which is in jet aircraft.

Pigeon Courier Service Aids NASA Aerospace Contractor

Homing pigeons have found a roost in the computerized aerospace world of one of NASA's major contractors, Lockheed Missiles & Space Company. The feathered couriers are carrying microfilm data from the company's main plant in Sunnyvale, Calif., to its test base in the Santa Cruz mountains.

Lockheed's newest employees are traversing the 25-mile span in about half the time it takes an automobile to cover the distance over trafficked highways and twisting mountain roads.

According to Lockheed, interplant pigeon service was born of both need and inspiration which arose in the following way. Designers and engineers at the Santa Cruz test base use a computer graphics design and drafting technique called CADAM®. To use CADAM, they operate a Santa Cruz terminal (a keyboard and video display screen) that is connected by microwave to computers at Lockheed's Sunnyvale facility. The results of each day's design work are stored in the Sunnyvale computers.

But to achieve design continuity, the Santa Cruz people each morning needed an immediate printout of all work completed by the end of the previous day.

That printout could not be produced at Santa Cruz without installing expensive equipment. And getting that information on microfilm from Sunnyvale by express courier service also was quite costly.

Inspiration came to the rescue. Robert Nelson, a design specialist at Lockheed's Santa Cruz base, recalled seeing a television show in which homing pigeons were used to fly blood samples from various hospitals to a central laboratory at a great savings in cost and in time.

He interested Werner Deeg, a research scientist who heads the chemistry laboratory at Santa Cruz, a man with a penchant for things of nature. Says Nelson: "When I first mentioned a possible pigeon service to our base manager, his reaction was expected: he laughed. But he agreed we should try it." Lockheed did, with Deeg becoming the entrepreneur who is developing the pigeon flock.

In operation, the pigeon service works this way. Santa Cruz design drawings each day are extracted from Lockheed's computers at Sunnyvale and converted to microfilm. A strip of film is rolled into a small plastic tube attached to the pigeon's leg.

The pigeon (a pair is delivered to Sunnyvale daily by routine in-plant truck service) is then released and flies to its home loft at the Santa Cruz test base in about 40 minutes. There the film is printed as an enlarged drawing and given to the designer who can continue with the next computer-aided design step.

The success of this pigeon service would have been predicted by pigeon fanciers and those aware of the historical exploits of homing pigeons. The records of these reliable birds, whose homing instinct still is not fully understood by investigators, includes both peacetime and wartime achievements.

The carrying of blood samples is a recent one. Others are more historical, such as the pigeon service used by Julius Reuter (founder of the news agency which bears his name) in 1850 to carry up-to-date financial news from the Brussels stock exchange to Aix-La-Chapelle (Aachen) Germany.

Or the flight of the famous "Cher Ami" during World War I, a heroic bird who flew through enemy fire and though badly wounded, successfully delivered a message which enabled the rescue of a trapped American battalion of the 77th Division.

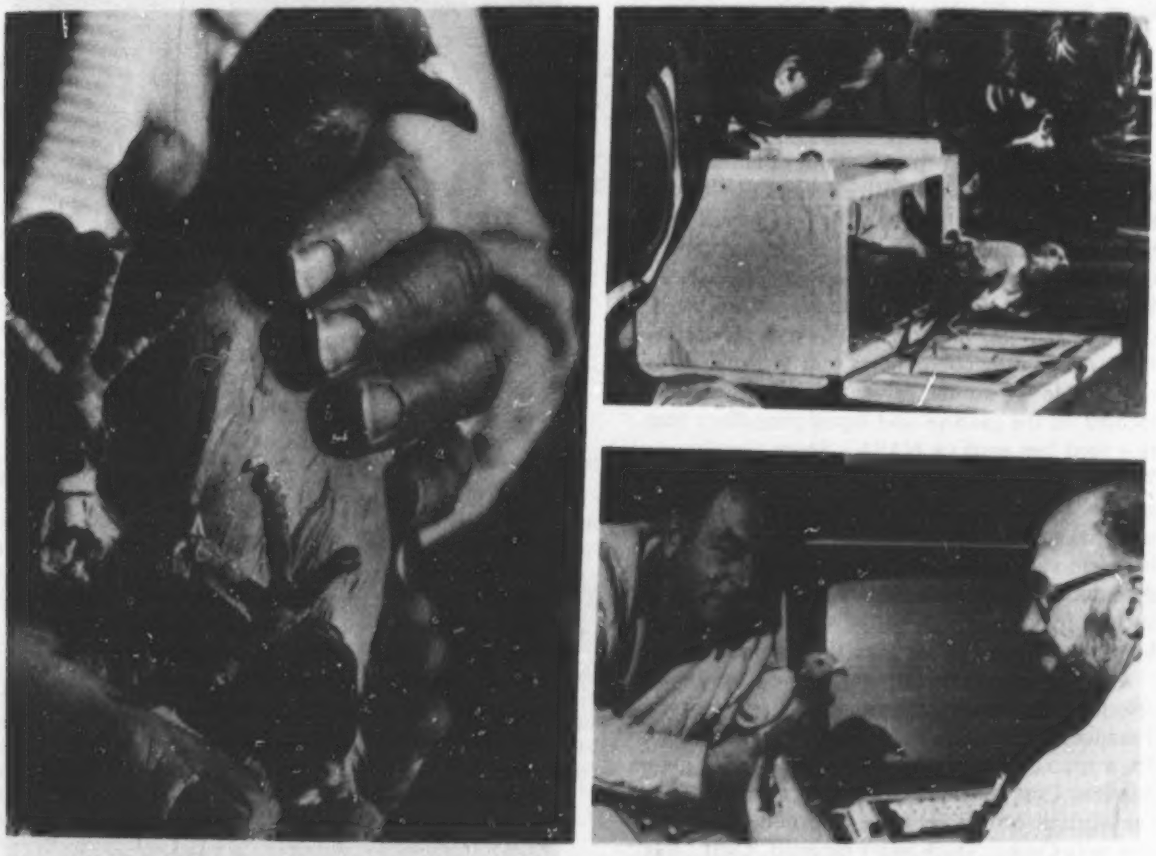
Or even the record flight of one bird, from France to Saigon—a distance of 7,200 miles which the pigeon traversed in 24 days.

Experience has shown that over distances of a few hundred miles, pigeons are almost 100 percent reliable. From Lockheed's facility at Sunnyvale to its Santa Cruz test base, the distance is moderate—to pigeons just an exercise flight. But it is another confirmation of the service done by these birds who through their entrance into this arena of technology, are adding another line to their fascinating history.

Inspector General Activities

Upon receiving a claim for payment from a NASA contractor, an alert NASA employee questioned the validity of the claim. Subsequent review of the claim by NASA and the Office of the Inspector General resulted in the conclusion that not only was the claim marked up, but that it should be disallowed as nonfactual, based on the lack of supporting documentation. Further evaluation of the firm's records subpoenaed by a Federal grand jury was performed by the Office of the Inspector General. Although criminal intent could not be established, the claim has been withdrawn by the contractor and, in so doing, has resulted in a cost avoidance to NASA of approximately $400,000.

On January 27, 1982, a Federal grand jury issued an indictment charging three NASA contractors and



Lockheed microfilm carried by a pigeon courier is contained in a capsule attached to the pigeon's leg (left photo) with a padded Velcro band, quickly detachable when the bird arrives at its home loft in the Santa Cruz mountains. In top photo, a pigeon takes off from Sunnyvale with its "mail" for Santa Cruz as Lockheed personnel Tom Birley and Linda Marvin observe. Pigeon domestication dates to 3,000 B.C. The merging of that ancient means of communication with modern technology is symbolized in bottom photo where Werner Deeg, Lockheed research scientist, holds a bird in front of the computer-design terminal and Robert Nelson, Lockheed design specialist displays the film that the pigeons deliver daily to Santa Cruz.

three of their employees with fraud. The indictment alleges that over a period of several years the defendants conspired to file false statements in connection with construction contracts of support facilities for the Space Shuttle. One defendant has pleaded guilty to filing false statements and has been sentenced to pay $10,000. The indictment culminates a three-year investigation by NASA's Office of the Inspector General and the FBI.

NASA's Office of the Inspector General urges you to continue your efforts in meeting the challenge of improving NASA programs. Suggestions for eliminating waste and mismanagement are welcome. Identities can be confidential. A 24-hour answering service is available in the Washington, D.C. area on 755-3402, or call (800) 424-9183 (toll-free for all other areas). Please send written suggestions to: NASA Inspector General, P.O. Box 23089, L'Enfant Plaza Station, Washington, D.C. 20024

Contractor News

Wiltech Florida Corp., Titusville, Fla., has been awarded a cost-plus-award-fee contract by NASA's Kennedy Space Center, Fla., for component refurbishment and chemical analysis services at the Center. The amount of the contract award is $3,054,939 and covers the period from Mar. 1, 1982 through Feb. 28, 1983. Wiltech is a small business firm. Among the components that Wiltech will be responsible for are the valves and pumps that are located on the gaseous and liquid propellant lines that feed fuel used by NASA's Space Shuttle. Wiltech will also take over KSC's chemical analysis service. Much of the chemical observation will be undertaken by the technique of gas chromotography, in which various liquids and gases are separated to determine if any impurities are present. Shuttle fuels such as hydrazine, used in the shuttle orbiter's onboard propulsion systems, go through this process.

Martin Marietta Aerospace, Denver, has been selected by NASA's Jet Propulsion Laboratory, Pasadena, Calif., for negotiations to study options for a spacecraft for a potential Venus radar mapping mission. Cost for the study contract and duration of the work effort are yet to be determined.

S & Q Corp., South San Francisco, Calif., has been awarded a contract valued at approximately $1 million, by NASA's Langley Research Center, Hampton, Va., for the design and fabrication of components for a water jet propulsion system. The components, a large diameter, high-pressure propulsion control valve, jet nozzle and safety gate system, will be used for the modification of the Aircraft

Number Three—Third successful launch of the Space Shuttle Columbia from NASA's Kennedy Space Center, Fla., March 22 at 11 a.m. EST.

Landing Dynamics Facility at Langley which enables Langley scientists to perform aircraft and spacecraft landing gear research. The facility uses a water jet system to propel a test carriage equipped with landing gear along a rail/track system under simulated runway conditions. The new propulsion system will be capable of accelerating the test carriage to 220 knots within 400 feet. Under the terms of the firm-fixed-price supply contract, the S & Q Corporation will be responsible for the design, fabrication, assembly, delivery and tests of the propulsion system.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	March 22	KSC	OSS-1
Columbia (OV-102)	July	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-B, Telesat-E

*Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Insat 1A	April 8	Delta	ESMC	India communications. Reimbursable.
NOAA-E/SAR	June	Atlas-73E	WSMC	NOAA/SAR weather. Reimbursable.
Navy 21	June	Scout	WSMC	DOD transit. Reimbursable. Callup.
Intelsat V-E	July	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Landsat-D	July	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August	Delta	ESMC	Canada communications. Reimbursable.
Westar-V	September	Delta	ESMC	Western Union communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

*Successful launch

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
James R. Currie and Raymond R. Schansman, NASA/MSFC	Photoelectric detection system	4,319,133	MSFC
Robert E. Frazer, Caltech/JPL	Constant magnification optical tracking system	4,320,290	NRO/JPL
Nick J. Constantinides, Caltech/JPL	Echo tracker/range finder for radars and sonars	4,320,397	NRO/JPL
Kenneth E. Wood, Rockwell International Corp., Downey, Calif.	High temperature penetrator assembly with bayonet plug & ramp-activated lock	4,320,911	JSC
Richard J. Stirn and Yea-Chuan M. Yeh, Caltech/JPL	Method of fabricating Schottky barrier solar cell	4,321,099	NRO/JPL
Robert E. Frazer, Caltech/JPL	Strong thin membrane structure for use as solar sail comprising substrate with reflective coating on one surface and an infrared emissivity increasing coating on the other surface	4,321,299	NRO/JPL
Philip A. Studer and John Paulkovich NASA/GSFC	Non-contacting power transfer device	4,321,572	GSFC

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Home Energy Efficiency

A spinoff of NASA technology developed for the Apollo spacecraft has resulted in a home design that is exceptionally energy efficient and known as the Watt Count house.*

Watt Count originated at Arnold Engineering Development Center, Tullahoma, Tenn., whose engineers worked in test and evaluation of Apollo Systems, specifically energy transfer research. On a lunar mission, temperatures outside the Apollo spacecraft ranged from a searing 400 degrees Fahrenheit to a supercold minus 400 degrees. Yet inside Apollo, astronauts worked in an atmosphere approximating homelike conditions, thanks to a highly advanced environmental control system whose total energy expenditure was equivalent to that of ten 150-watt electric light bulbs—the Watt Count System.

The first Watt Count homes, built during the early 1970s, showed impressive results; today more than 600 of these homes have been built.

Watt Count uses computerized energy consumption analysis on plans for a new home. The company calculates heating and cooling loads and customizes the most energy-efficient system for the structure. Optimum insulation is combined with a specifically designed heat pump central heating and air conditioning system.

Watt County officials say their design and analysis techniques are so accurate that they are able to give homeowners a 2-year guarantee that the home's energy consumption will not exceed the kilowatt hour level determined by the computer in their energy consumption analysis.

A distinguishing Watt feature is the use, usually on walls exposed to the outside, of a highly effective aluminized heat shield once employed as a radiation barrier on the Apollo command and lunar modules and on other space systems. This material holds in or keeps out radiant heat, air flow and water vapor. Another key factor is the careful selection of insulating materials, several types of which may be used on a single structure.

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*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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About the Cover

Launch of the third Space Shuttle on March 22 from NASA's Kennedy Space Center, Fla. Launch time for the 8-day mission was 11 a.m. EST. In photo below, this flight's prime crew, Jack R. Lousma (left) and C. Gordon Fullerton make a brief statement for the press before departing Ellington Air Force Base, Houston, for Kennedy on March 20. Also present were their families (bottom photo). Left to right: Mary Lousma, Gratia Lousma, Matthew Lousma, and Marie Fullerton. Children in front are Andrew and Molly Fullerton.

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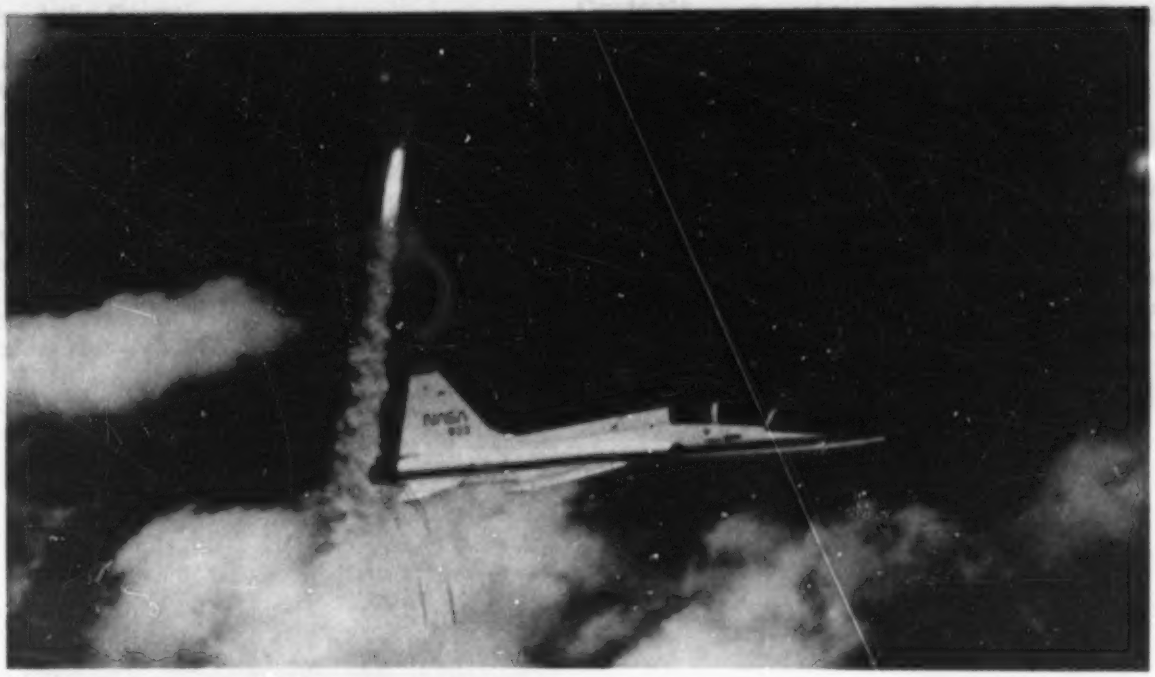
Shuttle Flight 3—Pictorial Highlights

Launch day for the third Space Shuttle, March 22, 1982, launch pad 39A, Kennedy Space Center, Fla. The spacecraft's external fuel tank was unpainted for the first time. Official mission elapsed time for this busiest and most successful test flight was 8 days, 4 minutes, 49 seconds. Below is a helicopter view of the crowds that lined the NASA Causeway for the launch. Public interest in Space Shuttle launches continues to be strong; crowd capacity for this launch was estimated at several hundred thousand spectators.



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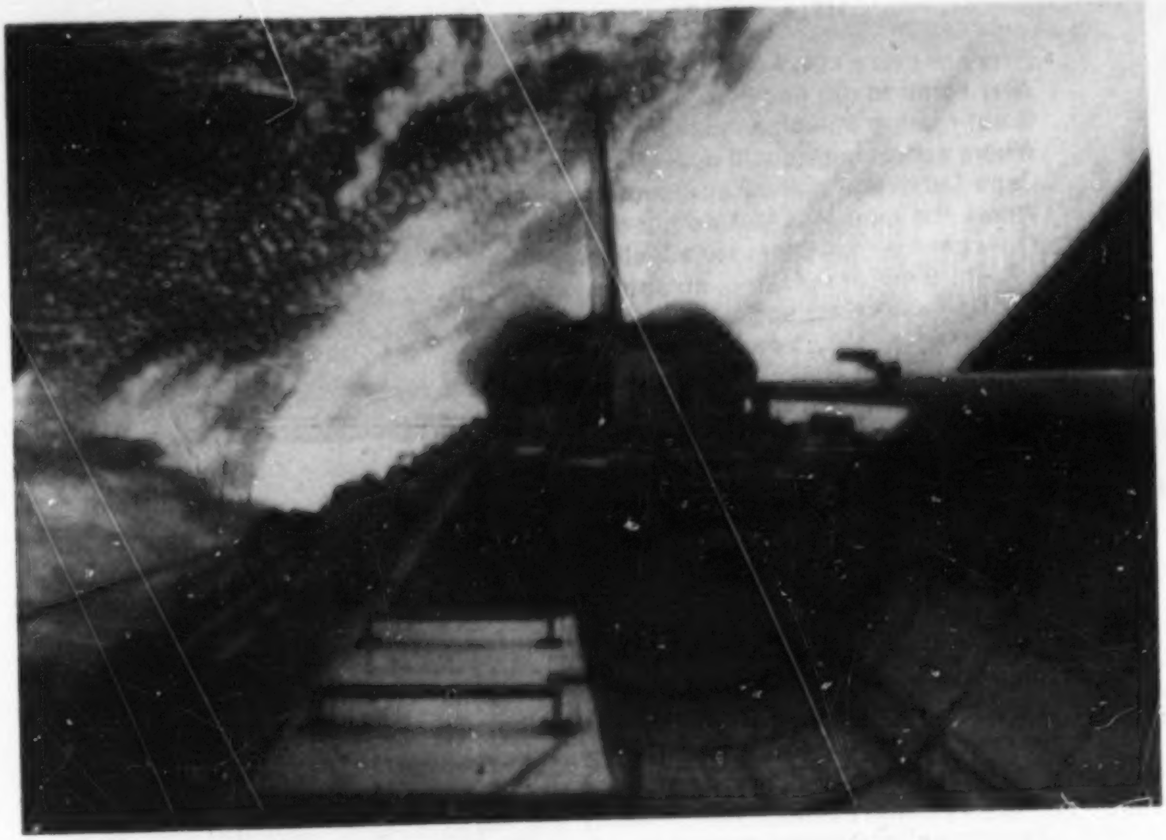


Page 4, top: Photo taken of the Space Shuttle Columbia from a NASA chase plane. In forefront is a second chase plane from which television imagery was recorded.

Page 4, bottom: UTC Liberty, one of two solid rocket booster recovery ships in the "NASA Navy", tows a spent booster from the third launch of Columbia through Port Canaveral after recovery operations in the Atlantic.

Page 5: Photo of the Columbia's cargo bay made from a live television transmission from the spacecraft on the opening day of the third flight.

When I Fly the NASA Space Shuttle

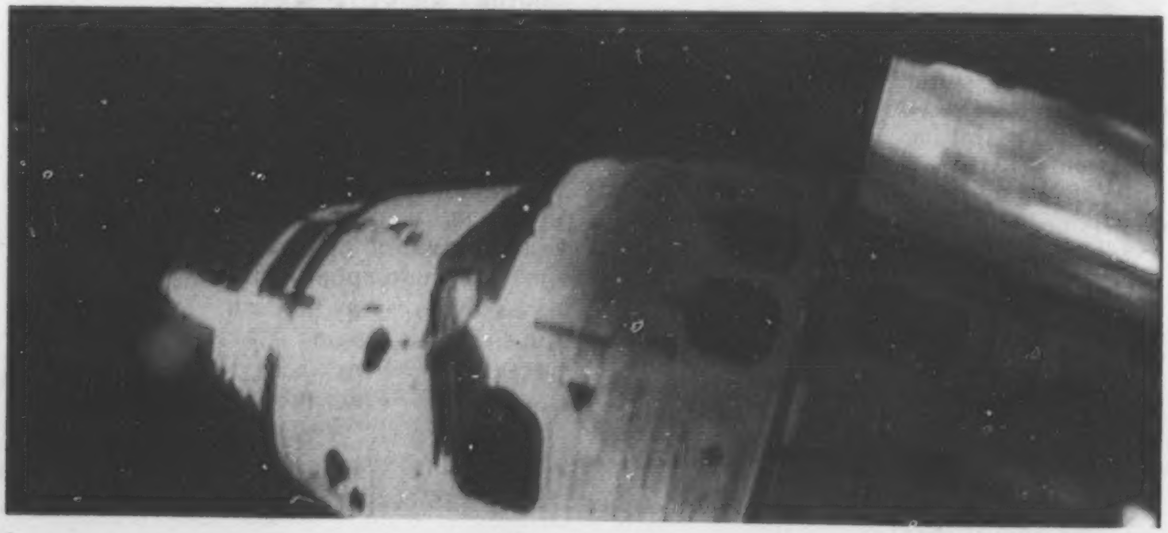
When I fly the NASA Space
Shuttle I will be relieved;
Relieved of the times and
patience I had to wait. Relieved
of the hard work I had to
do.
It won't be the life I really
new; it will be the life of the
final frontier.
But to leave the ground of
that big round sphere, known
as Earth from way up here.
But that's all dreams, I'll
never fear, my wish now, to
conquer the "Final Frontier."

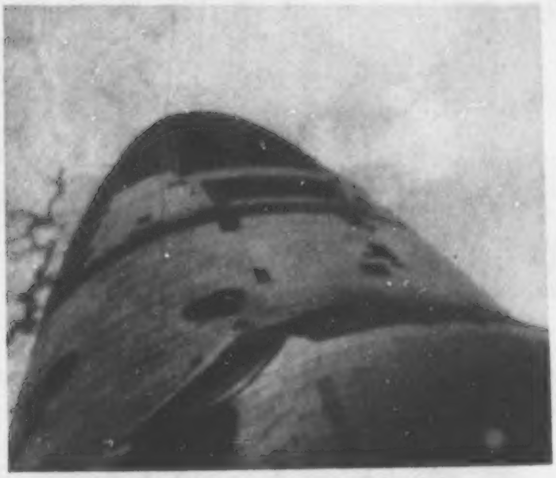
Author Unidentified
Age 5-7 years

HELLO' NASA

Who are these creatures who dare to enter our shell,
Who come to our heavens where in tranquility we dwell?
Great roaring machines making circles in our space,
Where some day we will greet them face to face.
Cape Canaveral is their aeronautical paradise,
Where the men of NASA do not compromise or sacrifice.
Their genius took them for a walk on our moon,
A giant step for mankind, an astronaut's boon.
Their satellites are sprinkled in our atmosphere
Where celestial bodies in radiant brilliance appear.
We live in orbit where many mysteries abound,
We could have told them that their earth is round.
They strive to visit Venus, Jupiter and Mars,
Treasured planets which have long been ours.
We seek knowledge of their terrestrial gravitation
And our flying saucers challenge identification.
We monitor their exploratory missions, one by one,
But we warn them, "Earth men, stay away from our sun."
We hold master keys to the vault in our sky
A spiritual rendezvous which we glorify.
Their Columbia has twice made history in flight,
A worthy accomplishment, a demonstration of power and might.
So keep blasting off and the future will decide
The merits of your projects and the quantum of your pride.
Your adverturers reflect your tenacity and reliance
May the enlightenment gained be a benefit to science.

David Randolph Milsten
Tulsa, Oklahoma





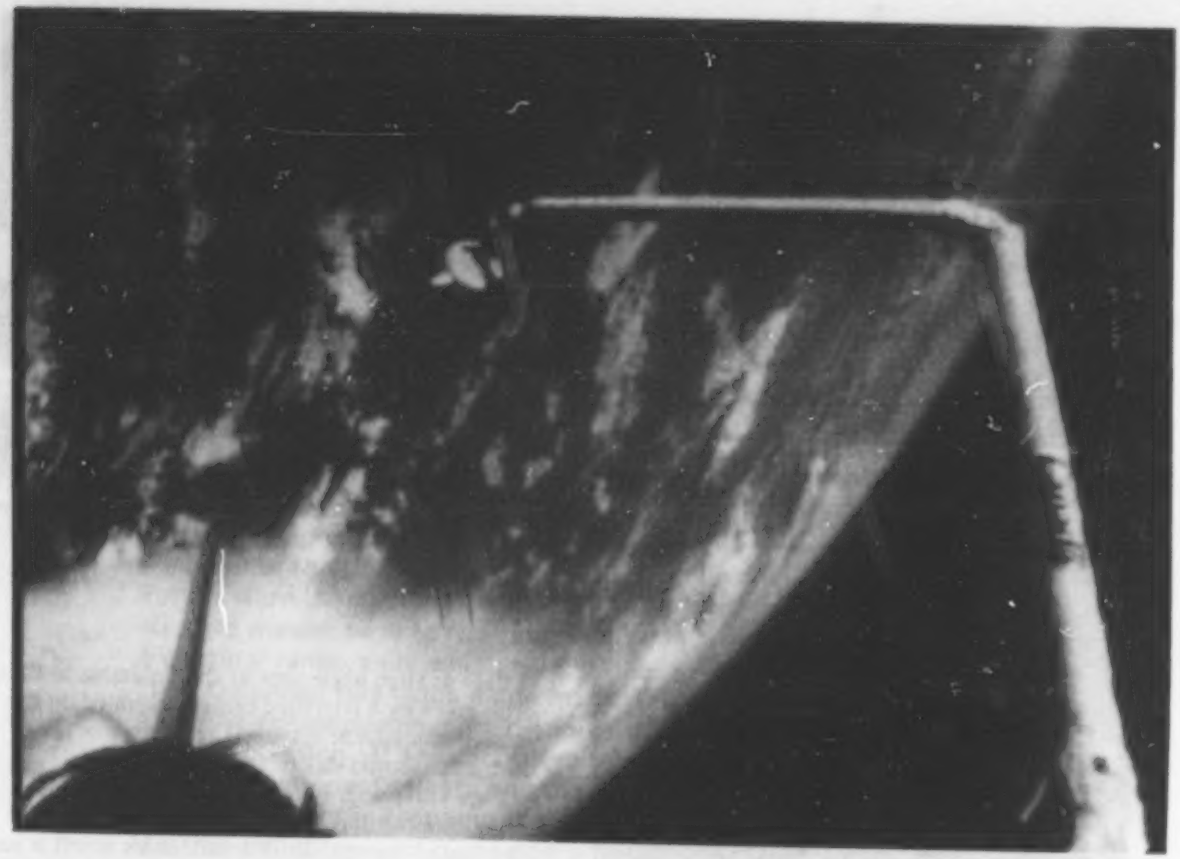
Page 6: High angle view of the Columbia in Earth orbit taken by a television camera mounted on the remote manipulator system. The photo was taken during the second day of the 8-day mission.

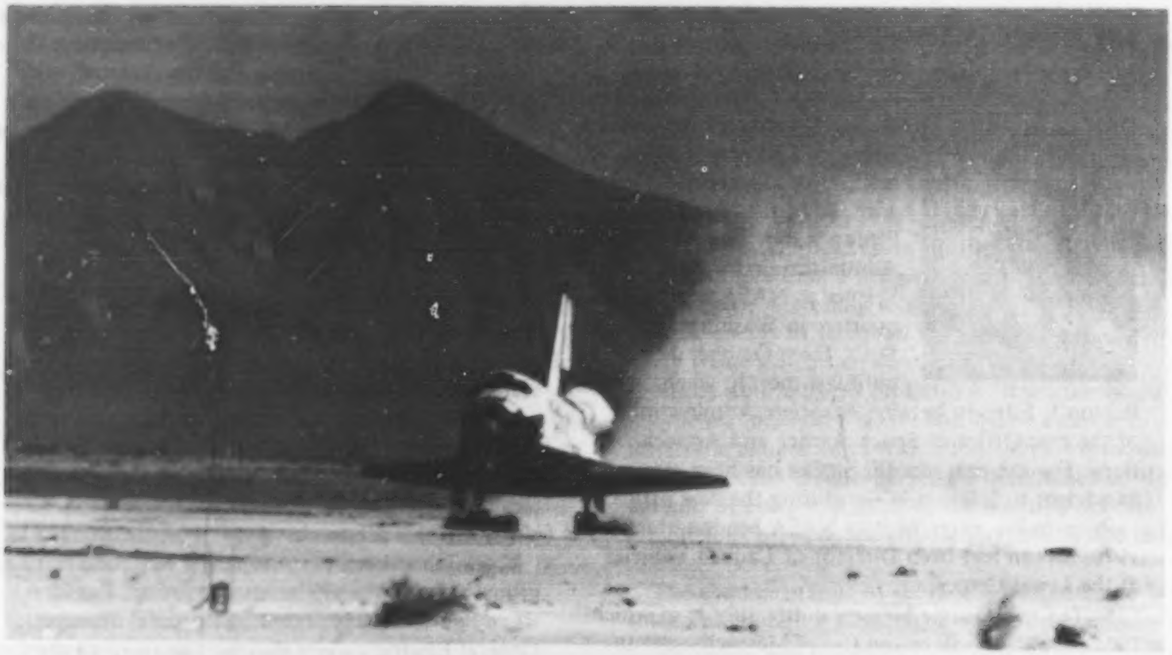
Page 7, top left: Photo taken from a live television transmission from the Columbia during the first day of the mission. The land mass at left is part of the East Coast, Chesapeake Bay area. Part of Columbia' cargo bay, orbital maneuvering system pods and vertical stabilizer are visible at lower right.

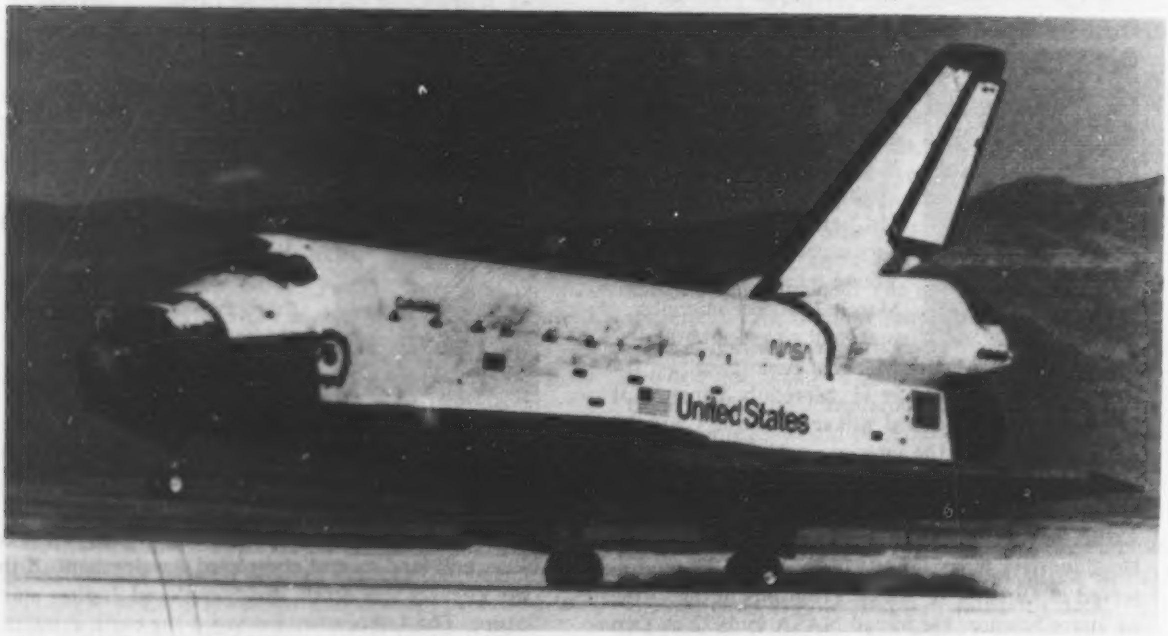
Page 7, center left: View of Columbia's nose and portion of fuselage taken from a television transmission during the second day of the mission which shows the absence of several white thermal protection system tiles. The tile loss had no impact upon the mission.

Page 7, bottom left: High angle view of Earth taken from Columbia's remote manipulator system elbow camera during the third day of the mission. The Columbia was in a nose-to-sun attitude which allowed for visibility over a large portion of the Earth.

Page 7, top right: From the fourth day in orbit, a photograph of the Space Shuttle's remote manipulator system deployed with the Plasma Diagnostics Package. This was the first time the robotic arm grappled and maneuvered a payload in space. The Plasma Diagnostics Package, part of the OSS-1 payload, is a comprehensive assembly of electromagnetic and particle sensors developed by scientists at the University of Iowa.







Page 8, top: Another view of the PDP payload deployed during a series of tests performed on day four of the mission.

Page 8, bottom left: View of the third Shuttle prime crew at the aft work stations of the orbiter: commander Jack Lousma at foreground; pilot Gordon Fullerton at back.

Page 8, bottom right: Watching Dad in space from Johnson Space Center is Andrew Fullerton.

Page 9: Touchdown of Columbia at White Sands Missile Range, Tuesday, March 30, at 9:05 MST. Poor weather conditions shifted the landing site from Edwards Air Force Base, Calif., to the New Mexico site. Columbia had made 129 orbits of the Earth and had traveled approximately 3.4 million miles.

Key Personnel Changes

Andrew J. Stofan has been named Director of the Lewis Research Center in Cleveland, Ohio, succeeding Dr. John F. McCarthy, Jr. Stofan was Acting Associate Administrator for Space Science at NASA headquarters in Washington, D.C., from October 1980 until last month, when Dr. Burton I. Edelson became Associate Administrator of the new Office of Space Science and Applications. For the past month, Stofan has been serving as advisor to Edelson in structuring the new office.

Prior to his assignment to NASA headquarters in 1978, Stofan had been Director of Launch Vehicles at the Lewis Center.

Stofan will assume his new duties July 1, at which time McCarthy will return to the Massachusetts Institute of Technology, Cambridge, as Professor of Aeronautics and Astronautics.

Dr. Noel W. Hinners, Director of the National Air and Space Museum, has been appointed Director of NASA's Goddard Space Flight Center, Greenbelt, Md., effective June 14. Hinners succeeds A. Thomas Young who left Goddard March 22 to become vice president of research and engineering for Martin Marietta Aerospace, Bethesda, Md. Dr. Leslie H. Meredith, Director of Applications at Goddard will serve as the Center's Acting Director in the interim.

Hinners became Director of the National Air and Space Museum in April 1979. Prior to that he was Associate Administrator for Space Science at NASA Headquarters from June 1974 to April 1979 and he served as Director of Lunar Programs in the Office of Space Science. He joined NASA in 1972 as Deputy Director and Chief Scientist, Apollo Lunar Exploration.

Hinners served as chairman of NASA's Lunar Dust Erosion Study Committee in 1969-70, and the Apollo Photo Data Users Group in 1971. He was also chairman of the Apollo Site Committees for Apollo 12-17 missions. He currently chairs NASA's Solar System Exploration Committee.

Daniel J. Fink, senior vice president for corporate planning and development with General Electric Co., Fairfield, Conn., has been named chairman of the NASA Advisory Council by agency Administrator James M. Beggs. He assumed the chair on March 11.

The NASA Advisory Council is composed of senior industry executives, leading scientists and eminent public figures and serves as the agency management's senior advisory group on aerospace policy and program planning. As chairman, Fink will direct the advisory activities of the council itself as well as those of six committees that report to the council.

Prior to his present assignment with General Electric, Fink had been the company's vice president and group executive for its aerospace group. Earlier, when he was vice president and general manager of General Electric's space division, he received the Collier Trophy, the nation's most prestigous aerospace award, for his contributions to the Landsat Program.

Dr. Bruce C. Murray has announced his resignation later this year as Director of NASA's Jet Propulsion Laboratory, Pasadena, Calif. A search for his successor is underway. Dr. Murray's announcement came as he entered his seventh year in the position. A member of the California Institute of Technology faculty since 1960, Dr. Murray became JPL's Director on April 1, 1976. He said he plans a year-long sabbatical, including extensive travel and writing. During the past six years, JPL has conducted the mission operations of the Viking Mars orbiters and landers and completed development of the two Voyager spacecraft which explored Jupiter and Saturn. The Laboratory managed the earth satellite projects, Seasat and Solar Mesosphere Explorer; is managing the Infrared Astronomy Satellite; and is developing the Galileo Jupiter orbiter and probe.

Prior to his appointment to head JPL, Dr. Murray was associated with the first space explorations of Mars, Venus and Mercury. From 1961 to 1973, he was co-investigator on the television science experiments on the Mariner 4, 6, 7, and 9 Mars missions. He was team leader of the 1974-75 Venus and Mercury television science investigations by Mariner 10.

Gerald D. Griffin, vice president of Scott Science and Technology, Inc., Scottsdale, Ariz., will succeed Dr. Christopher C. Kraft, Jr., as Director of NASA's Johnson Space Center, Houston, at the end of this year. Kraft announced his resignation from the agency in April. He has headed the Johnson Center for the past decade. Griffin left NASA in August to join Scott Science; prior to this position he served as the Deputy Director of NASA's Kennedy Space Center.

From July 1980 until August 1981, Griffin filled a dual role as NASA Headquarters Acting Associate Administrator for External Relations and Deputy Director of Kennedy, spending approximately 25 percent of his time at KSC.

In other NASA positions, Griffin served as Deputy Director of Dryden Flight Research Center, Edwards, Calif. and as a flight director at Johnson Space Center on all 11 Apollo missions. He was lead flight director on Apollos 12, 15 and 17.

Satellite Detects Drop in Sun's Energy; Possible Factor in Weather on Earth

An 18-month decrease in the Sun's energy output, recently detected by a NASA satellite, may have been a factor in this year's unusually harsh winter, according to a scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif.

This winter's severe weather conditions in the United States, coupled with results from an experiment on the Solar Maximum Mission satellite, may be the first direct observation of a cause and effect relationship between the Sun's energy output and changes in Earth's weather and climate, according to JPL Solar Max investigator, Dr. Richard Willson.

A persistent decrease of a tenth of a percent in the total amount of solar energy reaching Earth (called solar irradiance) was detected over an 18-month period from February 1980 to August 1981 by the Active Cavity Radiometer Irradiance Monitor experiment on the satellite.

Climatologists are already studying the results of the experiment which will be correlated with such global climate indicators as average temperatures, ice coverage and sea level to evaluate the effects of the drop in solar irradiance.

A systematic increase or decrease in the Sun's release of energy—as little as one half percent per century—can produce vast changes in Earth's climate. Scientists believed that a one percent decrease would lower Earth's mean global temperature by more than 1 degree Kelvin (2 degrees Fahrenheit). According to some models, a decrease in solar energy of less than 10 percent could effectively freeze Earth's entire surface.

Nearly all life forms on Earth exist within the 10 kilometers (6.2 miles) above and below mean sea level. The temperatures within this thin environmental shell, called the biosphere, are determined by the amount of energy received by the Sun and delicate interactions between the atmosphere, ocean and land masses.

The climatic effects of short-term variations in solar irradiance are moderated by the heat capacity of the ocean and atmosphere. A long-term increase or decrease, however, can eventually change the temperature of the ocean and atmosphere enough to change the weather and climate.

"These kinds of small but persistent trends in solar irradiance are believed to have been causes of climatic changes in the past," Wilson said.

Solar magnetic activity reaches a maximum approximately every 11 years. The peak of the current solar cycle (called solar cycle 21), occurred in early 1980, about the time the Solar Maximum Mission satellite was launched. The irradiance decrease detected by the monitor may be related to the general decline in solar activity since then. However, the decrease might be an indication of a longer-term trend in the Sun's irradiance. Years of careful measurements would be required to identify such a trend.

In its two years of operation, the irradiance monitor also observed short-term increases and decreases, lasting from days to weeks, in the amount of solar energy that reaches Earth. Analysis indicates the decreases are the effects of sunspots, dark, cooler patches on the Sun, while increases are caused by faculae, which are bright, extra-hot solar regions.

The monitor also detected evidence of solar oscillatory phenomena—global pulsations whose effects extend deep into the Sun. The oscillations had a five-minute periodicity. These five-minute oscillations match ground-based observations discovered in the 1970s. Study of this phenomenon, so-called "solar seismology," will provide new information on the inner workings of the Sun that cannot be obtained by other means.

During most of Earth's history, the climate appears to have been considerably warmer, with average global temperatures about 25 C (77 F). The current average global temperature is 15 C (59 F).

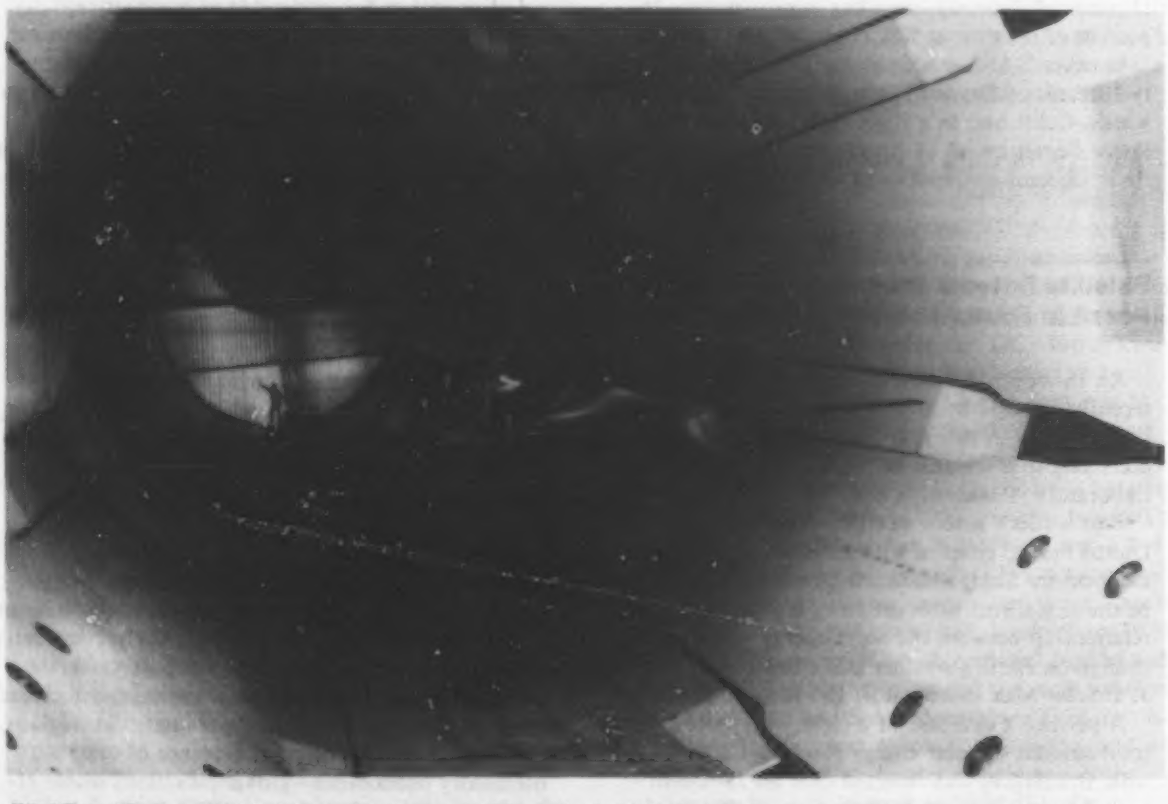
A gradual trend to a cooler climate began about 100 million years ago, resulting in the glacial climate of the last 20 million years. At least four major glacial epochs, each lasting nearly 100 million years, have occurred in the last billion years. The last epoch ended 250 million years ago. The present glacial period may yet prove to be another major epoch.

The Solar Maximum Mission was launched Feb. 14, 1980. In December, after 10 months of normal operation, the satellite's attitude control system lost its capability to point precisely at the Sun. A less precise pointing technique was subsequently achieved by spinning the spacecraft so that it rotates every six minutes. In this configuration, three of the satellite's seven instruments continue to acquire useful data.

The Sun crosses Solar Max's Active Cavity Radiometer Infrared Monitor field of view several times per orbit, providing an adequate quality and quantity of data for the experiment's primary mission objectives, though the data are deficient in some solar physics information (like the observation of solar oscillations).

While the spin-stabilized pointing allows continued study of the Sun, the satellite's 550-km (340-mi.) orbit is slowly decaying due to atmospheric drag.

At the present rate of decay, the Solar Maximum Mission satellite will reenter Earth's atmosphere in 1984. Its demise will leave at least a three-year gap



Wind Tunnel Testing—Model of the B-1 bomber mounted for testing in NASA Langley Research Center's Transonic Dynamics Wind Tunnel. Work on this tunnel, the world's first aeroelastic testing tunnel, was completed early in 1960 after eight years of intensive design and calibration. Langley is one of NASA's lead aeronautics centers, specializing in aeronautical and space structures and materials; advanced concepts and technology for future aircraft; aerodynamics of reentry vehicles; space environmental physics; and improved supersonic flight capabilities.

in the precise record of solar irradiance observations made for the National Climate Program. The earliest successor experiment to the irradiance monitor is planned for deployment on NASA's Upper Atmospheric Research Satellite (UARS) in 1987.

Solar Maximum Mission was the first NASA satellite designed to be retrieved by the Space Shuttle. An effort to retrieve the satellite, repair it on orbit and redeploy it is being studied by NASA. The rejuvenated satellite would allow scientists to observe a wide range of solar phenomena in a different part of the solar activity cycle and sustain solar irradiance monitoring with the precision required for climate studies.

Authorization for the proposed Solar Maximum Mission repair mission is currently under consideration by Congress.

The irradiance monitoring experiment is conducted by the Jet Propulsion Laboratory as part of the Environmental Observations program of NASA's Office of Space Science and Applications. Solar Maximum Mission is managed by NASA's Goddard Space Flight Center, Greenbelt, Md.

Astonomers Detect Violent Ejection From A Star Near Sun

What is believed to be the first direct evidence of a violent ejection or jet from a star relatively close to the Sun has been detected by astronomers at NASA's Goddard Space Flight Center, Greenbelt, Md., the University of Maryland and the Lick Observatory at the University of California.

Most of the jets that are observed by astronomers indicate violent ejection of matter from the center of active galaxies or quasars. This most recent observation, however, reveals an extraordinary jet structure in a binary star system near the Sun, known to astronomers as the star R Aquarii. In contrast to the only other star known to have jet structure in our galaxy, SS 433, R Aquarii is much closer to the Sun, a distance of only 750 light years.

Dr. Andrew Michalitsianos of Goddard describes the jet, seen with the Very Large Array radio telescope located at Socorro, N.M., as "an extended, well collimated (directional) jet which is coincident with a similar structure seen in visible light by Dr. George Herbig with the 305-centimeter (120-inch) telescope at the Lick Observatory. This jet has a length of about 20 times the size of our solar system."

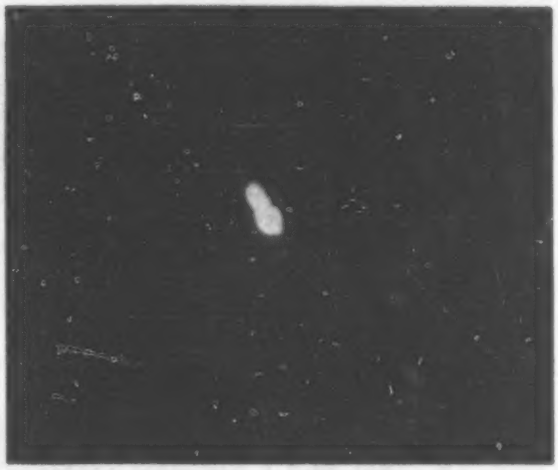


Photo taken by Dr. George Herbig of Lick Observatory, University of California on Oct. 18, 1980 of the red variable R Aquarii. The jet is the protruding feature extending from the image of the central star. The surrounding tenuous nebula has been known to exist around R Aquarii for a number of decades and is believed to be the result of tidal forces between the binary star components and material expulsion from the cool red giant star in the system.

Dr. Minas Kafatos, on leave from George Mason University, Fairfax, Va., who also is at Goddard, estimates that the material in the jet could be moving at 2,000 kilometers (1,080 miles) per second.

"We believe that the presence of a jet in R Aquarii is evidence for an accretion disk of material captured by an unseen star companion of the cool red variable R Aquarii," said Kafatos. The accretion disk, estimated to have a diameter 25 times the Earth's distance from the Sun, would be just observable with Space Telescope (due to be launched on the Space Shuttle in 1985) because of the proximity of this system to the Sun. Therefore, R Aquarii may be the only object in which astronomers can directly examine the formation of jet structure.

As Star SS 433 is 20 times farther from the Sun than R Aquarii, it would not provide a favorable opportunity for observation, astronomers said.

In a related development, radio observations of the jet structure by Robert Sopka of the University of Maryland, they said, showed a previously unknown radio source. If proven to be associated with R Aquarii, it may be material previously ejected during an outburst seen in the early 1930s, they said.

New observations are planned by the Goddard astronomers using NASA's orbiting International Ultraviolet Explorer telescope satellite.

Crews Named For Next Six Shuttle Missions

Astronaut crews for the fourth through ninth flights of the Space Shuttle have been announced by NASA. Among those selected will be NASA's first woman in space (flight seven) and the first black astronaut (flight eight) in space. Crewmen for **STS-4** are **Thomas K. Mattingly**, commander, and **Henry W. Hartsfield**, pilot. STS-4 is planned for launch in late June or early July for a duration of approximately seven days. It will be the last of four orbital flight test missions verifying Shuttle hardware and software subsystems.

STS-5 is scheduled for mid-November as a five-day mission to deploy commercial communications satellites. It will be the first flight to employ mission specialist astronauts. Mission commander is **Vance D. Brand** and **Robert F. Overmyer** is pilot. Mission specialists are **Dr. Joseph P. Allen** and **Dr. William B. Lenoir.**

Columbia is the spacecraft for both missions.

STS-6 will be the first flight of the Shuttle orbiter Challenger and is planned for January 1983. It will be a two-day mission to deploy NASA's Tracking and Data Relay Satellite, one of an eventual two-satellite system which will provide more comprehensive voice and data coverage between the ground and orbiting Space Shuttles. The crew is **Paul J. Weitz**, commander; **Karol J. Bobko**, pilot; **Donald H. Peterson** and **Dr. Story Musgrave**, mission specialists.

Crewmembers for **STS-7** are **Robert L. Crippen**, commander, and **Frederick H. Hauck**, pilot. **Mission specialist astronauts will be John M. Fabian** and **Dr. Sally K. Ride**. STS-7 is to be a six-day flight by the orbiter Challenger, with a planned launch in April 1983. Its payloads are to be a German shuttle pallet satellite (SPAS), the second Office of Space and Terrestial Applications instrument package (OSTA-2), a Canadian communications satellite (TELESAT-F) and an Indonesian communications satellite (PALAPA-B1).

STS-8 is scheduled for launch in July 1983. Announced as mission commander is **Richard H. Truly** and as pilot, **Daniel C. Brandenstein.** Mission specialists will be **Dale A. Gardner** and **Guion S. Bluford, Jr**. This three-day mission is to be the third flight of the orbiter Challenger. Payloads will be an Indian communications satellite (INSAT 1-B) and NASA's tracking and data relay satellite (TDRS-B), the second and final element in a system to give nearly full-time voice and data communication between orbiting Space Shuttles and mission control.

The first flight of Spacelab—the joint project between NASA and the European Space Agency—is presently scheduled for launch in September 1983. Mission commander for the seven-day flight of **STS-9** is to be **John W. Young** and pilot will be **Brewster H. Shaw, Jr.** Mission specialists will be **Dr. Owen K. Garriott** and **Dr. Robert A. Parker**. Additionally, two payload specialists—one each from NASA and the European Space Agency—will be named at a later date.

Backup crews will no longer be assigned to Space Shuttle flights. A pool of experienced Shuttle pilots now exists, and a crewman could be replaced with minimal impact to crew training and scheduling.

Thomas K. Mattingly

Henry W. Hartsfield

STS-4

Vance D. Brand

Robert F. Overmyer

Joseph P. Allen

William B. Lenoir

STS-5

Paul J. Weitz

Karol J. Bobko

Donald H. Peterson

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STS-6

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STS-8

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Frederick Hauck

John M. Fabian

Sally K. Ride

STS-7

John W. Young

Brewster H. Shaw, Jr.

Owen K. Garriott

Robert A. Parker

STS-9

Shuttle Thermal Protection System Being Improved

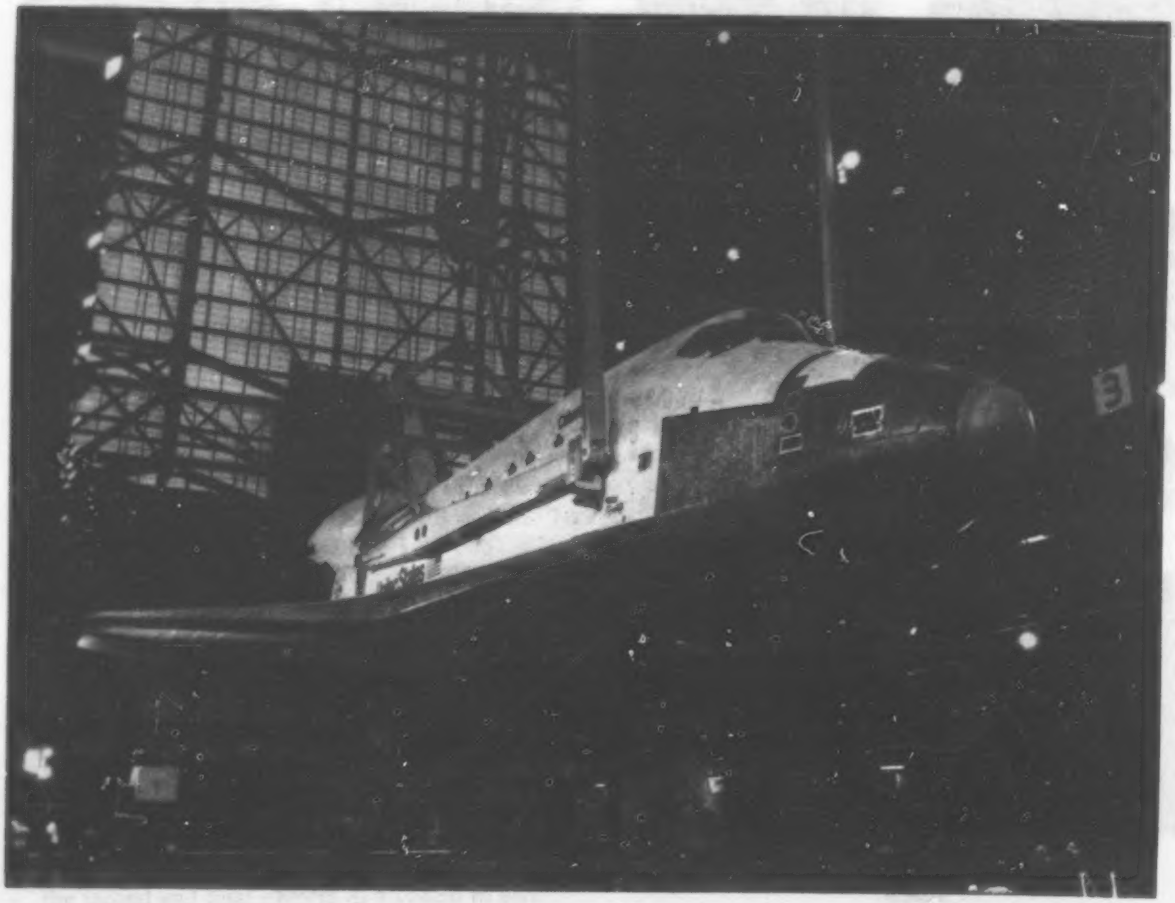
Lighter, stronger and more cost-efficient second generation materials, developed at NASA's Ames Research Center, Mountain View, Calif., are improving the Space Shuttle's thermal protection system. The thermal protection system is one of the more critical Shuttle elements as it protects the spacecraft from the extreme temperatures it encounters on its Earth-circling missions.

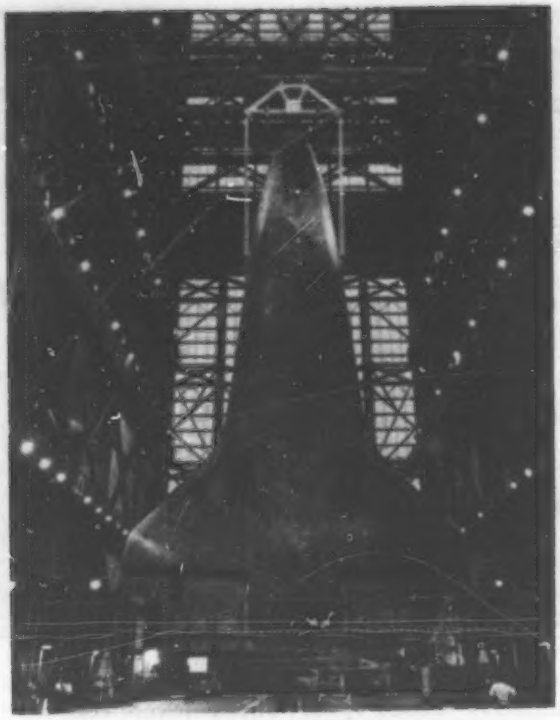
Some of the new materials were installed for the second mission of the orbiter Columbia, which made its third trip into space on March 22 from Kennedy Space Center, Fla. Other of the materials will be installed in stages on Columbia and the three additional Shuttle orbiters over the next several years: Challenger, now under construction with delivery expected this summer; and Discovery and Atlantis, scheduled for delivery in 1983 and 1984.

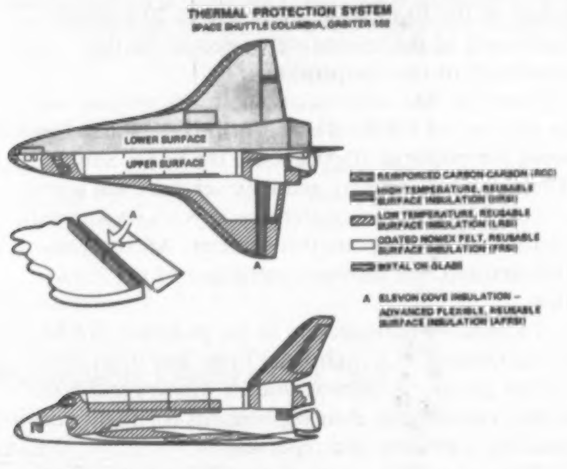
The Shuttle thermal protection system consists of tiles and other refractory materials applied to the outer shell of the orbiter to protect its aluminum and graphite-epoxy skin from extreme temperatures. Temperatures on a Space Shuttle flight may range from – 110 Celsius (– 170 Fahrenheit) in space to nearly 1,648 C (3,000 F) at some points during reentry.

Shuttle orbiter Columbia has had a silica glass quilt, called Advanced Flexible Reusable Surface Insulation installed over 1.85 square meters (20 square feet) of its elevon cove, replacing the Felt Reusable Surface Insulation which originally covered the area.

This felt insulation had to be replaced because temperatures in the elevon cove area reached 816 C (1,500 F) and the felt was designed for areas no hotter than 398 C (750 F). Plans had been to install the advanced flexible type in some areas on the next orbiter, Challenger, but the overheating brought a decision to add the new materials for the second flight of Columbia last November.






THERMAL PROTECTION SYSTEM
SPACE SHUTTLE COLUMBIA, ORBITER 102
LOWER SURFACE
UPPER SURFACE
A
REINFORCED CARBON-CARBON (RCC)
HIGH TEMPERATURE, REUSABLE SURFACE INSULATION (HRSI)
LOW TEMPERATURE, REUSABLE SURFACE INSULATION (LRSI)
COATED NOMEX FELT, REUSABLE SURFACE INSULATION (FRSI)
METAL OR GLASS
A ELEVON COVE INSULATION – ADVANCED FLEXIBLE, REUSABLE SURFACE INSULATION (AFRSI)

Orbiter Columbia in Kennedy Space Center's Vehicle Assembly Building showing side and underviews of the more than 30,000 thermal protection system tiles which cover the spacecraft's surface. Above is a diagram showing placement of the new advanced flexible insulation tile on the Columbia.

The advanced type is tougher, lighter and cheaper than earlier tile heat shields. It was conceived by Ames and produced by Manville Building Materials Corp., Denver, Colo. A square foot of new insulation costs about $200, compared to approximately $1,000 a square foot for tile materials.

On Challenger, the advanced flexible insulation will be installed on the orbital maneuvering system pods and will partially replace low temperature reusable surface insulation tiles developed and manufactured by Lockheed Missiles and Space Co., Sunnyvale, Calif.

On orbiters Discovery and Atlantis, the advanced flexible type will replace all the low temperature insulation and parts of the felt type, covering more than 250 sq. m. (2,700 sq. ft.).

Also on these future orbiters, another new material called Fibrous Refractory Composite Insulation (FRCI-12, 12 pounds per cubic foot) will replace LI-2200 tiles. Both of these materials were developed by Ames and are manufactured by Lockheed. The new fibrous insulation is lighter and stronger than LI-2200.

The fibrous type will save about 450 kilograms (1,000 pounds) on Discovery and Atlantis.

Four principal types of materials comprised the original thermal protection system: felt reusable surface insulation effective for temperatures less than 398 C (750 F); low temperature reusable surface insulation tiles, covered with a white borosilicate glass coating effective from 371 C (700 F) to 648 C (1,200 F); high temperature reusable surface insulation, covered with a black reaction-cured glass coating which is used for 648 (1,200 F) to in excess of 1,260 C (2,300 F); and reinforced carbon-carbon, effective for temperatures up to 3,000 F.

The low and high temperature tiles come in two densities: the LI-2200, 22 pounds per cubic foot, and LI-900, nine pounds per cubic foot. The latter material was developed and is manufactured by Lockheed.

The high temperature insulation is covered with the black, reaction-cured borosilicate glass coating developed by Ames to protect the high temperature areas, about 43 percent of the total surface of the orbiter. The white, borosilicate-coated low temperature tiles are located primarily on the upper surface of the orbiter.

Another Ames development used in the thermal protection system is the Ames gap filler, which fills nearly 5,000 gaps between tiles, where it prevents hot gas from reaching the Shuttle's aluminum skin.

Solid Rocket Booster Modification Proposed

NASA plans to make a change to the Space Shuttle's solid rocket boosters that will reduce their weight substantially and provide an increase in the Shuttle's payload carrying capacity by about 2,720 kilograms (6,000 pounds).

Pending approval for reprogramming of funds, NASA plans to replace eight of the 11 metal segments of the current booster motor case with four segments made from composite filament material. Other motor components, including the metal forward and aft domes and the external tank attach segment of the metal case, would remain unchanged.

A request for proposals has been issued for design and development of the filament wound case.

The new filament wound case is needed for high performance launches primarily into near-polar orbit from Vandenberg Air Force Base, Calif. The lightweight motor case will help compensate for reduced lift capabilities when launches from the West Coast cannot take advantage of the added velocity provided by the Earth's rotation. The filament wound case can also be used to boost extra heavy payloads into Earth orbit from Kennedy Space Center, Fla.

The lightweight case for the boosters was one of several options studied by NASA to increase the Shuttle's payload capacity. First use of the motor would be in late 1985.

Should the plans be approved, a series of test firings using filament wound case configured solid rocket motors will be conducted by the Thiokol Corp., Wasatch Div., Brigham City, Utah, under the direction of NASA's Marshall Space Flight Center, Huntsville, Ala.

Selection Begun in Second Shuttle Student Project Competition

Up to 200 semifinalists have been selected in the second national Space Shuttle Student Involvement Project, a joint effort of NASA and the National Science Teachers Association.

The object of the project is to stimulate the study of science and technology in grades 9 through 12 by engaging students in a competition to develop payload experiments suitable for flight aboard the Space Shuttle. The contract to conduct this competition and select the winners was awarded last summer by NASA to the National Science Teachers Association, with headquarters in Washington, D.C.

An experiment by student Todd E. Nelson of Rose Creek, Minn., a finalist from the first national competition, flew on the third Shuttle mission launched March 22 from Kennedy Space Center, Fla.

Since announcement of the second competition in August, the National Science Teachers Association has received more than 86,000 requests for contest materials.

Interested students first submit experiment proposals to their high school science teacher for review and screening for adherence to the rules of the competition. Teachers submit all eligible projects to the National Science Teachers Association for consideration.

By Feb. 1, the Association had received 2,900 entries in the competition. These proposals were grouped into 10 geographic areas or regions determined by the Association.

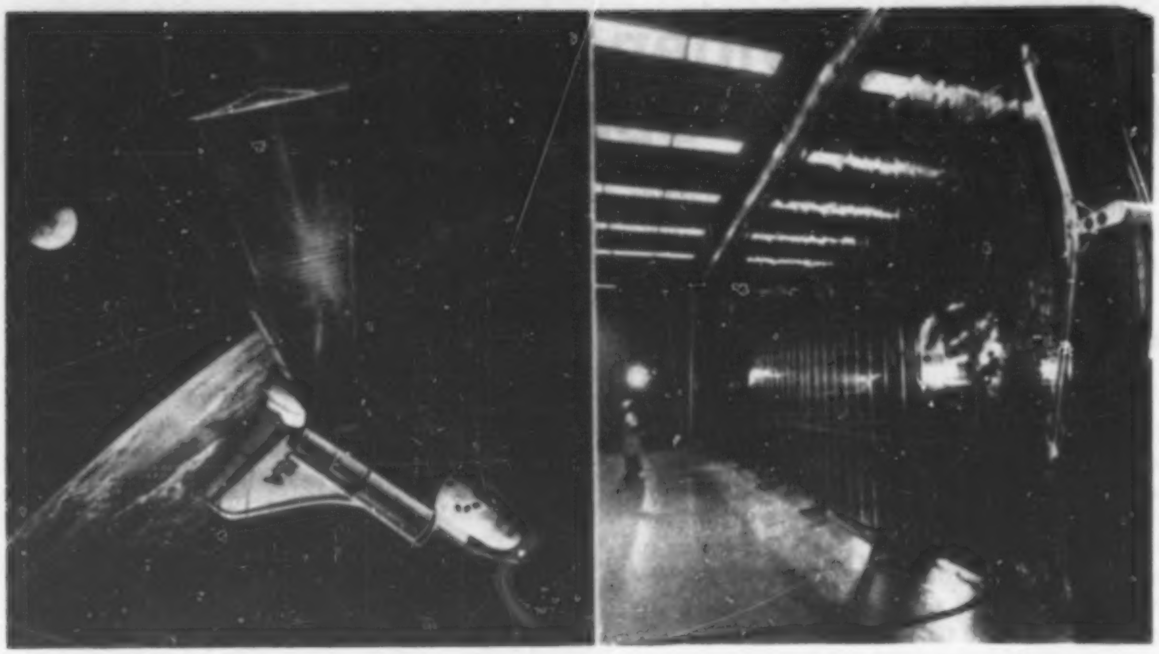
Interdisciplinary teams of teachers, scientists and engineers, selected by the National Science Teachers Association, were established to review these proposals at the 10 regional levels. Up to 20 students from each of the regions were selected for the semifinals of the competition.

From the 200 semifinalists, up to 20 projects will be selected on the basis of scientific or engineering merit for potential flight aboard the Space Shuttle. These national winners and their teachers will attend a special educational conference at NASA's Kennedy Space Center, Fla., late this summer. All competition entrants will receive a certificate of participation.

To broaden participation in the program, NASA is encouraging U.S. industrial firms and other non-NASA groups to sponsor student winners and assist them in developing their experiments for flight and post-flight analysis and reporting.

Winning student experiments will be assigned to specific Shuttle flights as the experiments are ready, as Shuttle payload space is available and as future Shuttle flights are confirmed.

A third Space Shuttle Student Involvement Project contest will open in September with that series of regional conferences to be held in March 1983. Selection of new groups of student winners will be made in May 1983.



Capturing Energy from the Sun – Artist concept (left frame) of a huge experimental solar array wing (right frame) developed by Lockheed Missiles and Space Company that will fly aboard the Space Shuttle in 1984. Tests conducted during the flight will verify that large area solar arrays are capable of supplying significant amounts of power for Shuttle operations. Measuring 105-ft. long by 13½-ft. wide, the wing will be folded like an accordion in the Shuttle cargo bay. Attached to the cargo bay, it will be extended and retracted several times in space to check its structural and dynamic characteristics and its electrical performance. When fully extended and fully populated with solar cells, the array wing's 84 electrical modules convert energy from the Sun to produce 12.5 kilowatts of power.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	March 22	KSC	OSS-1
Columbia (OV-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-B, Telesat-E

*Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1A	April 10	Delta	ESMC	India communications. Reimbursable.
Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
NOAA-E/SAR	June	Atlas-73E	WSMC	NOAA/SAR weather. Reimbursable.
Navy 21	June	Scout	WSMC	DOD transit. Reimbursable. Callup.
Landsat-D	July 9	Delta	WSMC	NASA earth resources applications.
Intelsat V-E	July	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
Telesat-G (Anik-D1)	August	Delta	ESMC	Canada communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

*Successful launch

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Aircraft Fuel Economy

Soaring fuel cost is the largest problem confronting commercial aviation today. Scientists at NASA's Lewis Research Center, Cleveland, are conducting research on advanced turboprop engines which offer inherently better fuel economy than jet engines.* Old turboprop engines with 4-bladed propellers produced excessive noise and vibration in high speed operation but did feature more efficient fuel use. In the days of inexpensive fuel, jets produced faster, quieter and more comfortable rides than the turboprops.

These reshaped propellers could enable turboprop aircraft to fly at or near jetliner speeds and altitudes and provide fuel consumption reduction of 30-40 percent. The accompanying photo shows a propeller model undergoing wind tunnel testing at Lewis. At right an engineer operates a laser velocimeter system which measures air velocities in the propeller's flow field.

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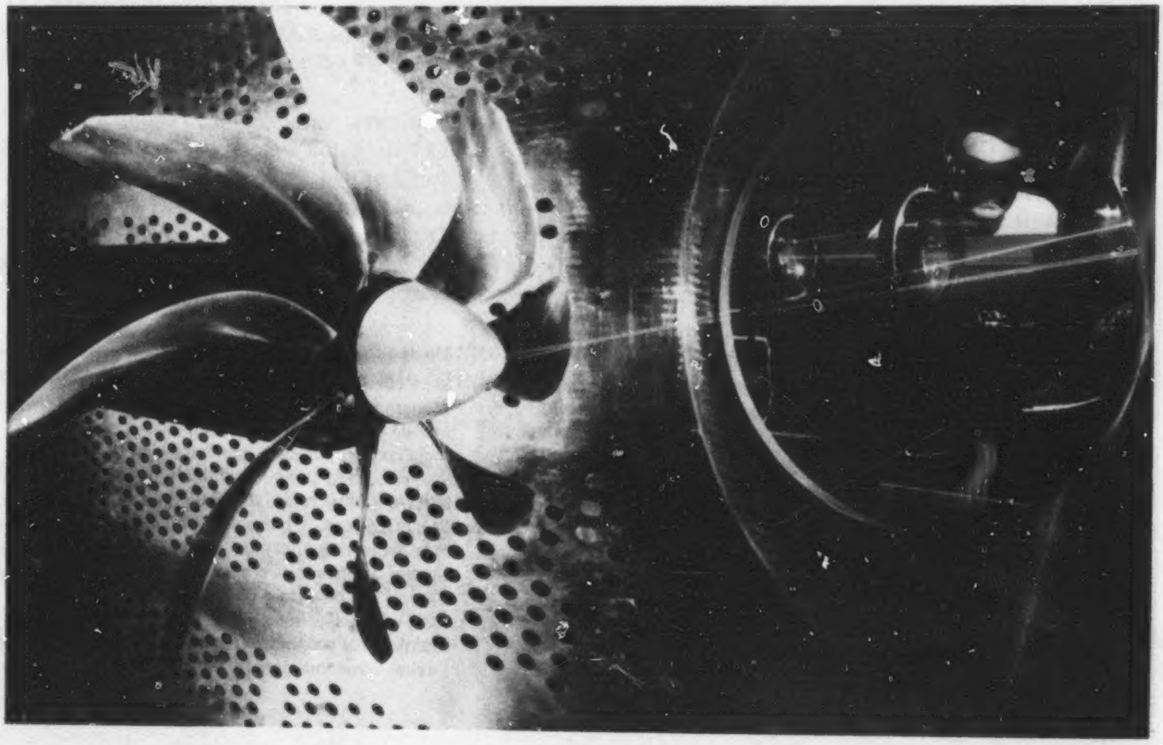
*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

NASA
National Aeronautics and
Space Administration

For the benefit of all . .



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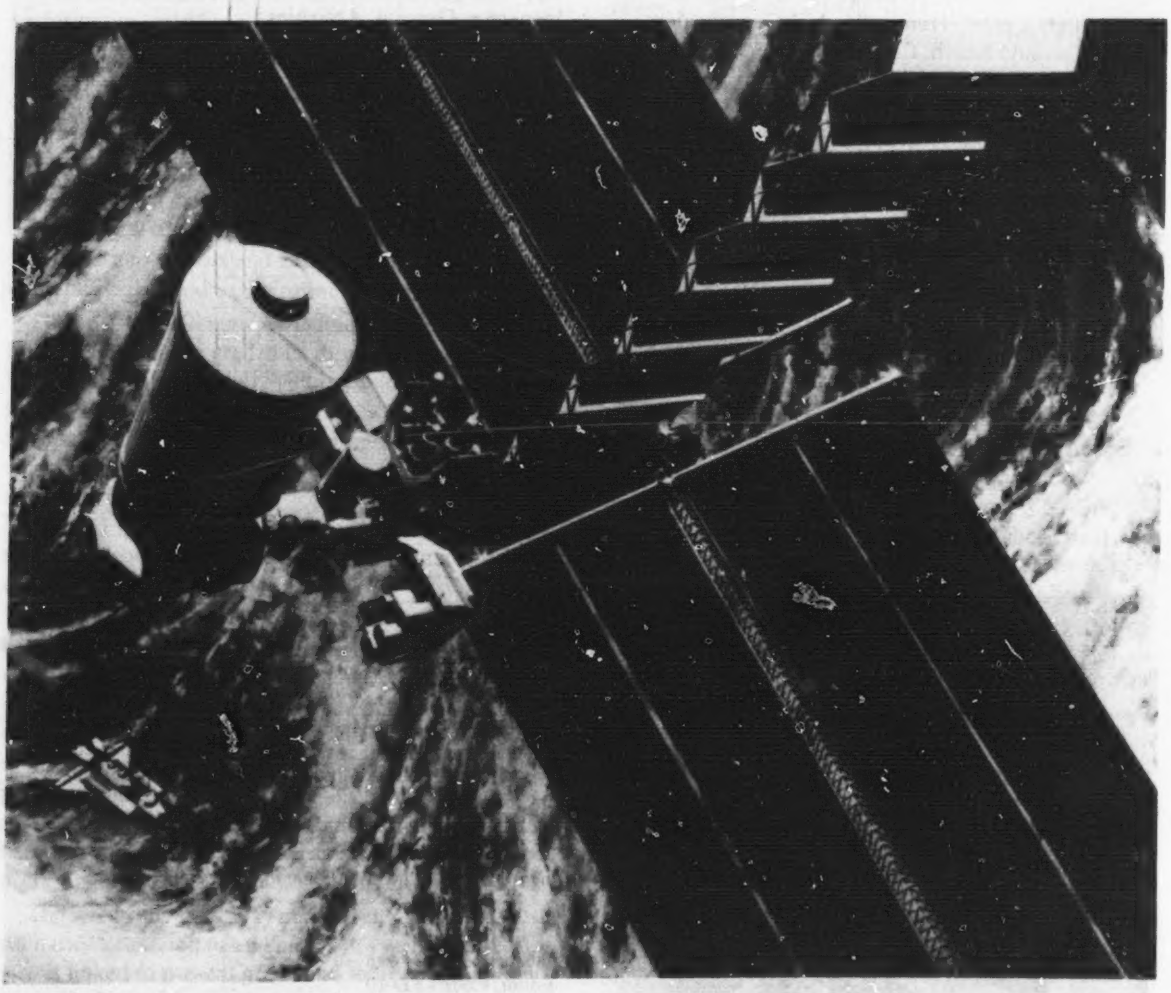

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About the Cover

Space Station by 1990?—NASA believes a space station is the next logical step in the development and utilization of space. In a major address on space stations delivered to the Detroit Economic Club on June 23, NASA Administrator James M. Beggs emphasized a U.S. space station would "make a vital contribution to our nation's future by opening new vistas of science and technology, new possibilities for commercial applications of space and new opportunities to enhance economic security and national defense." (This speech will appear in the July edition of *NASA Activities*.) On the cover is one of several reference concepts for a space station under review at NASA under sponsorship of the agency's Marshall Space Flight Center, Huntsville, Ala. Conceived by TRW, Redondo Beach, Calif., the space platform modular concept is developed to one of its potentials as a manned structure. Below is the Space Shuttle docked with this platform deploying a payload with the Remote Manipulator System. (An article on space stations also will appear in the July edition of *NASA Activities*.)

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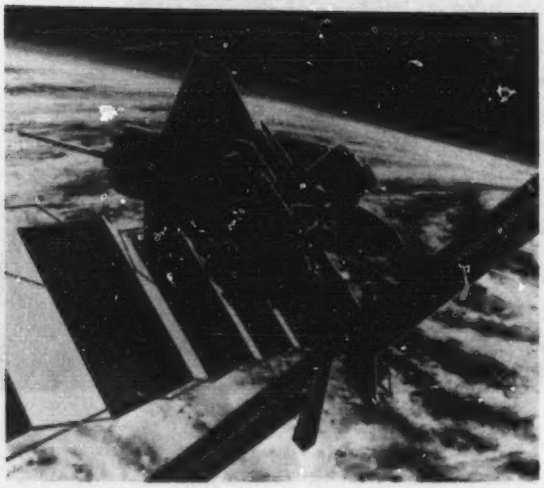

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Administrator's Column

(Each month in this column *NASA Activities* will feature an article by NASA Administrator James M. Beggs. These articles will focus on subjects chosen by him to address topics of broad interest to the agency's employees.)

Merit Pay—Rocky Beginning But Smoother Road Ahead

The disappointment that NASA's merit pay employees experienced with their first payout for performance in 1981 will not be repeated in 1982. Agency funding available for merit pay salary increases will be twice as much as in 1981.

Almost 3,000 NASA management officials and supervisors were put under the new Merit Pay System in October 1981. Under the Civil Service Reform Act of 1978, each federal agency was charged with establishing a compensation framework for its GS-13, 14 and 15 supervisors and management officials based upon individual and organizational performance.

Under the old General Schedule (GS) pay system for all employees in grades 13 through 15, an individual's salary within a grade could be increased in several ways during a given year: (1) annual pay raise comparability adjustment granted to all Government employees by the White House and Congress each October; (2) within grade increase ("step increase") in accordance with a prescribed time schedule between steps; and (3) quality increase for outstanding performance.

For those under Merit Pay, in-grade steps have been removed. Employees receive one pay increase in October of each year, which includes one-half of the annual comparability increase given to GS employees and a merit pay component increase based upon performance ratings. Performance rating categories are unsatisfactory, minimally satisfactory, successful, highly successful or outstanding. Pay raises based upon these performance ratings are granted accordingly with larger increases for higher ratings.

The size of the merit pay component, while primarily a function of an employee's work appraisal, also is linked to present grade and salary and to funds available for pay increases from the "merit pay pool." Funding for the pool is derived from the amount of money normally spent on within grade and quality step increases plus one-half of the annual GS comparability increase.

The first payout under the Merit Pay System, however, did not in all cases meet the criteria of better pay for better performance. Many who earned high ratings under merit pay actually received smaller salary increases than GS employees who received in-grade raises. Thus, in those instances, supervisors who were expected to perform well both technically and as managers under merit pay were rewarded less for high performance than non-managerial employees at the same grade level.

The smaller payout resulted from a decision rendered by the General Accounting Office (GAO) *one month* before the Merit Pay System was placed into effect. In September 1981, the GAO determined that the Office of Personnel Management (OPM) had overestimated the amount of money agencies would have spent for within grade and quality increases for 1981. GAO thereby revised the computation used for determining this amount which, in turn, significantly reduced the funding available for merit pay pools in this first year.

In response to the GAO revision, OPM granted full comparability salary increases in 1981 to cushion the merit pool deficit. Salary increases received, however, were still substantially less than anticipated. But for 1982, the full merit pay pool will be operational and agencies will be able to give larger increases to its merit pay employees.

Nonetheless, for research and development agencies such as NASA, the Merit Pay System does not provide an adequate incentive program. At NASA, about 2,900 employees are merit pay management officials or supervisors at the 13 to 15 grade levels as compared to over 6,700 GS workers at the same levels.

Occupations in research and development uniquely provide employees with a dual channel opportunity for career advancement: either through individual accomplishment or managerial ranks. At NASA, this option is reflected by the unusual statistic of only one third of professionals in these grade levels being supervisors or management officials. Thus for NASA, the bulk of the work force in grades 13 through 15 does not fall under merit pay (as with most agencies) and is therefore not in competition for pay increases. For the group of employees charged with the dual responsibility of technical *and* managerial expertise, the merit pay component does not provide adequate reward for performance.

NASA is currently pursuing solutions to this pay system inequity in a two-fold manner: appeal to the

Office of Personnel Management and support of legislation designed to amend the system.

The Civil Service Reform Act contains a provision for agency exclusion from the Merit Pay System. NASA believes that it has been demonstrated that the system fails to provide an effective career incentive plan and is developing an appeal to OPM for exclusion. In the interim, however, the disparity of two pay systems can only be corrected by legislative action.

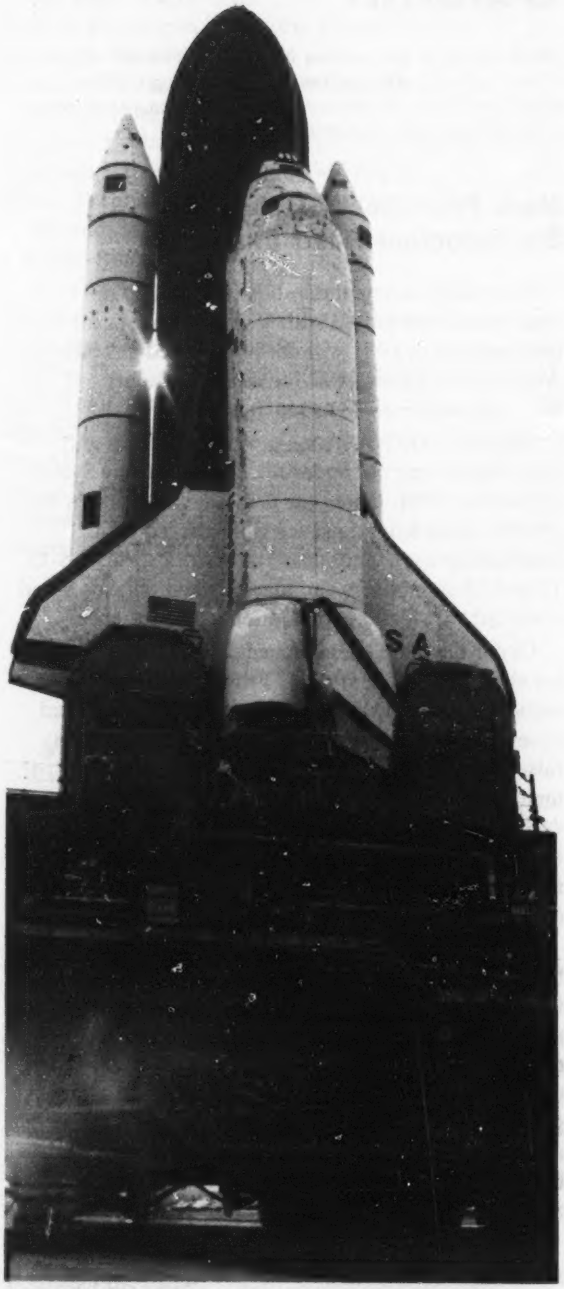
On March 4, Representative Frank R. Wolf (R-Va.) introduced legislation to replace the Merit Pay System in an attempt to "restore a measure of equity to the pay process for midlevel managers and supervisors in the Federal Government, GS-13 through 15."

Under Wolf's amendments, all satisfactory employees in these grades, not just managers and supervisors, would receive full comparability and step increases. For performance above the satisfactory level, Wolf proposes a "bonus pay system" be established. The minimum bonus proposed would be two percent of an employee's annual salary; the maximum not to exceed $10,000. Bonuses granted would be paid in one lump sum payment. Under this system Wolf believes "those employees who truly excel will enjoy a pay bonus commensurate with their efforts." NASA supports this legislation and has sent its endorsement to the Office of Management and Budget.

Space Shuttle Flight Four—Pre-Flight Background

Space Shuttle Columbia's fourth flight to be launched June 27 from NASA's Kennedy Space Center, Fla., is scheduled for seven days and will complete the shakedown of the Shuttle orbiter and booster systems as our nation's space transportation system becomes operational with flight five. Among top priorities listed for this mission are the continued studies of the effects of long-term thermal extremes on the orbiter sybsystems, a survey of orbiter induced contamination on the payload bay and a landing by the orbiter's autoland system.

Flight crew for the fourth Shuttle mission is commander Ken Mattingly, 46, and pilot Henry Hartsfield, 48. Mattingly, selected by NASA to be an astronaut in April 1966, was command module pilot



Rollout 4—Space Shuttle Columbia leaves Kennedy Space Center's Vehicle Assembly Building May 26 for its fourth rollout to Launch Pad 39A. This 3½-mile journey takes approximately eight hours to complete.

on Apollo 16, launched April 16, 1972. He has logged 265 hours in space—1 hour and 13 minutes of that time spent in extravehicular activity. Hartsfield has been a NASA astronaut since September 1969. He was a member of the astronaut support crews for Apollo 16 and Skylab missions 2, 3 and 4. Mattingly and Hartsfield were the backup crew for Shuttle flights two and three.

Columbia will be launched into a circular orbit above the Earth with an inclination to the equator of 28.5 degrees. Two burns of the orbital maneuvering system (OMS) engines will place Columbia in a 130 nautical mile (150 statute mile) circular orbit. A third and fourth burn of the OMS engines on the fifth revolution will place Columbia in a circular orbit 160 n. mi. (184 mi.) above the Earth.

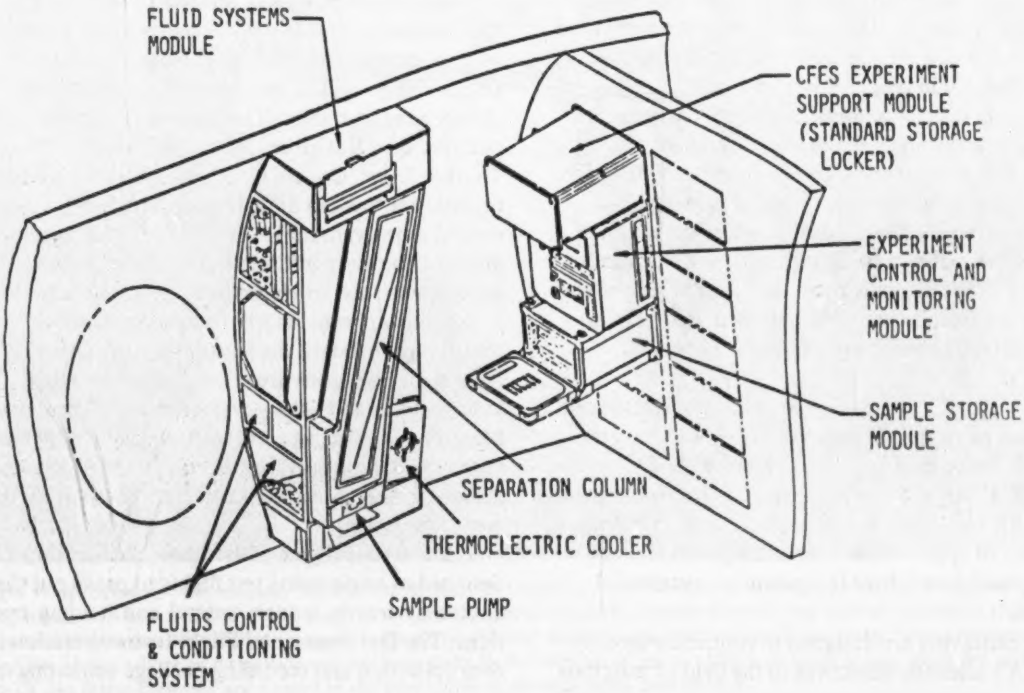
Launch window for the fourth flight will last 4 hours, 24 minutes. The window tentatively will open at 11 a.m. EDT and extend until 3:24 p.m. for a nominal late June launch. The end of the window is restricted to a Trans-Atlantic abort into Dakar, Senegal no later than 15 minutes after sunset.

Columbia will operate in several different attitudes during the 169-hour flight. For the first 20 hours of the mission, the orbiter will rotate in a "barbeque" fashion in the Passive Thermal Control mode designed to stabilize the orbiter's systems in a relatively benign environment. For five hours the orbiter will fly with its top to the Sun, followed by 66 hours in an attitude where the tail faces the Sun. Columbia will then turn its broad belly toward the Sun for 33 hours. Prior to reentry, Columbia will fly the final 10 hours of the mission in a gravity gradient attitude.

Principal cargo to be carried on Shuttle flight four is a classified Department of Defense payload designated DOD 82-1. Other experiments will be carried in the cargo bay and in the orbiter's mid-deck.

An experiment that marks the first use of the Space Shuttle by a commercial concern tops the list of civilian payloads scheduled to be carried into space on this mission: the **Continuous Flow Electrophoresis System** experiment. This experiment will separate biological materials in a fluid according to their surface electrical charge and is part of a NASA/McDonnell Douglas Astronautics Company "joint endeavor agreement" to conduct research in space. Scientists from the Ortho Pharmaceutical Division of

CONTINUOUS FLOW ELECTROPHORESIS SYSTEM
MIDDECK GALLEY LOCATION


FLUID SYSTEMS MODULE
CFES EXPERIMENT SUPPORT MODULE (STANDARD STORAGE LOCKER)
EXPERIMENT CONTROL AND MONITORING MODULE
SAMPLE STORAGE MODULE
SEPARATION COLUMN
THERMOELECTRIC COOLER
SAMPLE PUMP
FLUIDS CONTROL & CONDITIONING SYSTEM

Johnson & Johnson are collaborating with McDonnell Douglas in this effort.

Unlike previous electrophoresis experiments in space, this system processes considerable quantities of materials carried in a continuous stream. This flight will serve as an initial engineering test of the McDonnell Douglas-provided experiment hardware and will involve the separation of proteins and other natural biological matter in six samples. Materials obtained from this experiment could lead to commercial marketing of new medicines unobtainable without the benefit of zero gravity.

Gravity limits the concentration of the materials in the sample being separated, which is one of the primary factors limiting the electrophoresis production of commercial quantities on Earth. On Earth, only 0.25 percent of the sample to be separated can be biological material; the rest must be carrier fluid. In space, however, the concentration can be increased to 20 percent or more of the total sample, thereby increasing the output of the process by a factor of 80 to 100 over Earth processing.

Also on Earth, the sample stream size must be restricted to minimize gravity-induced disturbances to measure only one-half millimeter in diameter, while in space the diameter may be increased to one millimeter. This increases the output of the process by a factor of four, and when combined with the increase from higher concentrations, can result in an overall increase in output of 300 to 400 times when compared to an Earth-based unit. In addition, purer materials can be obtained in space.

On Earth, heat caused by the electric current used in the separation process induces convection, which reduces the purity of the separated materials. In space, the voltage may be increased without causing disturbing convective flows. Also, in space the length of time that the material being separated is in the electric field may be increased without detrimental side effects. This, in conjunction with the increased voltage, can significantly improve the purity of the separated materials.

NASA's joint endeavor agreement with McDonnell Douglas is pioneered and managed for NASA by the Materials Processing in Space Projects Office at Marshall. Under such an agreement, private enterprise and NASA work together as partners to promote the utilization of space where a technological advancement is needed and there is a potential commercial application.

Joint endeavors are designed to contribute directly to NASA's scientific objectives in the field of materials processing and to simultaneously accelerate the benefits to the general public from this technology. With the Continuous Flow Electrophoresis System experiment, both McDonnell Douglas and NASA will benefit from the use of this equipment for space experimentation in materials science.

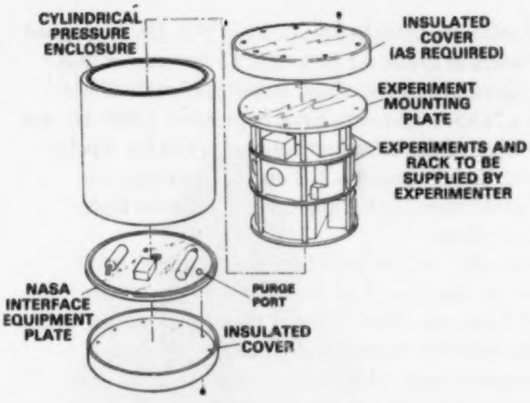

CYLINDRICAL PRESSURE ENCLOSURE
INSULATED COVER (AS REQUIRED)
EXPERIMENT MOUNTING PLATE
EXPERIMENTS AND RACK TO BE SUPPLIED BY EXPERIMENTER
NASA INTERFACE EQUIPMENT PLATE
PURGE PORT
INSULATED COVER

Diagram of NASA's container concept for "Getaway Specials" or Small Self-Contained Payloads.

Program manager for this experiment is James Rose, McDonnell Douglas Astronautics, St. Louis, Mo.; joint endeavor agreement manager for the project is Walter Wood, Marshall Space Flight Center, Huntsville.

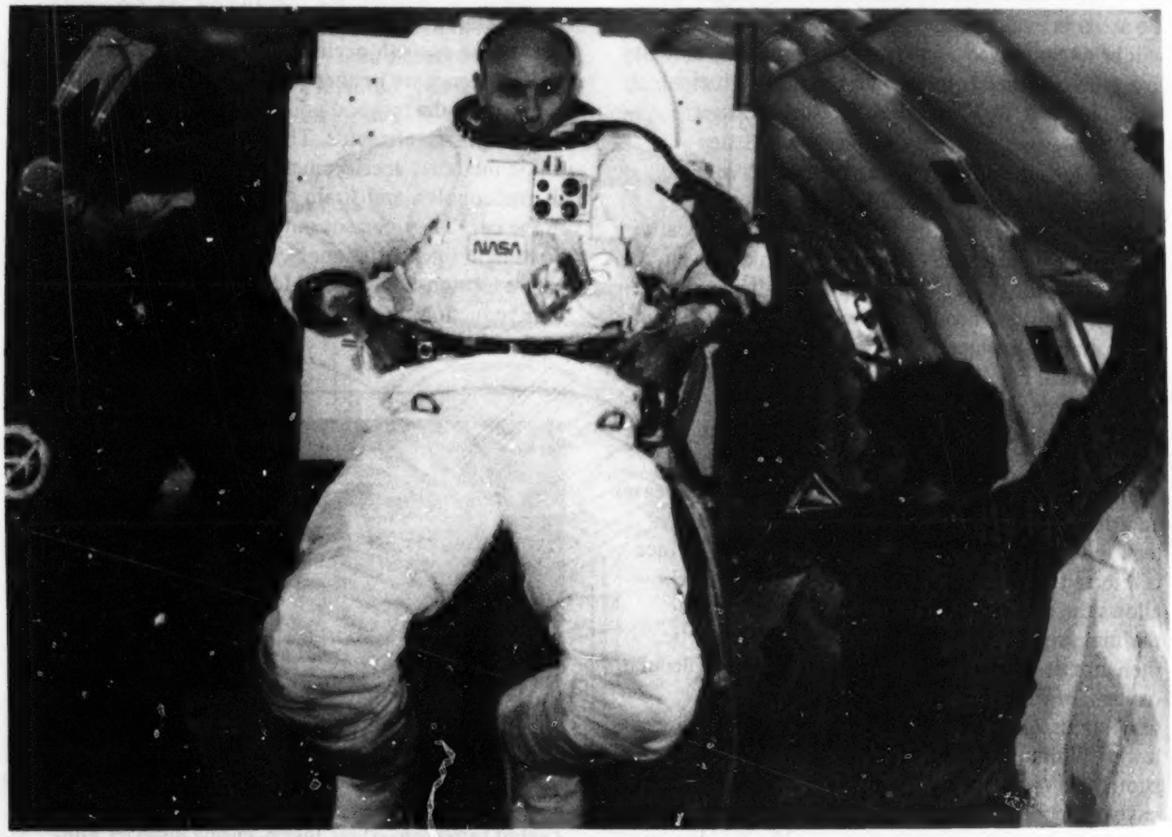
NASA's first **"Getaway Special"** will fly on this fourth mission. Inside the 2½ cubic foot canister will be nine experiments that range from algae and Duckweed growth in space to fruit fly and brine shrimp genetic studies. The Getaway Special was purchased by R. Gilbert Moore, a manager at the Thiokol Corp., Ogden, Utah. He subsequently donated the canister to Utah State University where it is being used in a program for student-constructed experiments. (For more information on these student experiments, see article on page 12 of this issue.)

Several experiments will be making their third and fourth flights aboard the Shuttle. Among those carried on previous missions are: Developmental Flight Instrumentation Package, Aerodynamic Coefficient Identification Package and several orbiter experiments such as Catalytic Surface Effects, Tile Gap Heating Effects and Dynamic, Acoustic and Thermal Environment experiment.

The first four flights of the Space Shuttle are designed as engineering test flights to prove out the Shuttle system in launch, orbital and landing operations. The **Developmental Flight Instrumentation** is a data collection and recording package consisting of three magnetic tape recorders, wideband frequency division multiplexers. a pulse code modulation master unit and signal conditioners. The recorders can record 28 tracks of wideband analog data on systems conditions and performance simultaneously. The Developmental Flight Instrumentation package will be removed after this flight from Columbia's cargo bay.

Primary objectives of the **Aerodynamic Coefficient Identification Package** are: (1) to collect aerodynamic data during launch, entry and landing phases of the Shuttle; (2) to establish an extensive data base for verification of the Shuttle's aerodynamic performance and correlation with ground-based data, including assessments of the uncertainties of such data; (3) to provide flight dynamics data in support of other technology areas such as aerothermal and structural dynamics. Instruments in this package include dual-range linear accelerometers and rate gyros. Also included are the power conditioner for the gyros, the power control system and the housekeeping components. The package is installed colinearly with the geometric axes of the orbiter and post-installation measurements made to establish the position within 10 arc minutes. The instruments continuously sense the dynamic X, Y and Z attitudes and performance characteristics of the orbiter through these flight phases. The Aerodynamic Coefficient Identification Package also provides high rate sampling of the positions of orbiter control surfaces for recording with the package's attitude data. Principal technologist is D. B. Howes of Johnson Space Center.

For the **Tile Gap Heating** experiment, the Columbia will be instrumented with a removable panel 45.7 cm



Pre-flight Weightlessness—Commander for the fourth flight of Columbia, Ken Mattingly, undergoes a suit donning and doffing exercise aboard a NASA KC-135 "zero gravity" aircraft. A special parabolic pattern flown by the aircraft provides a short period of weightlessness. Mattingly's spacesuit is an extravehicular mobility unit used by astronauts when leaving the shirt-sleeves environment of the orbiter to go outside and perform tasks in the vacuum of space. Although there are no plans for such activity on this flight, crewmen are trained in the procedures as an emergency contingency.

(18 in.) square, which will carry 11 tiles of baseline material and size fitted to the underside of the orbiter fuselage. Gaps between tiles will be carefully calculated and controlled during fitting to ensure that the heating rates generated during entry will be no higher than those of the baseline tile array. The aim is to produce a design that will result in heating rates lower than those of the baseline system.

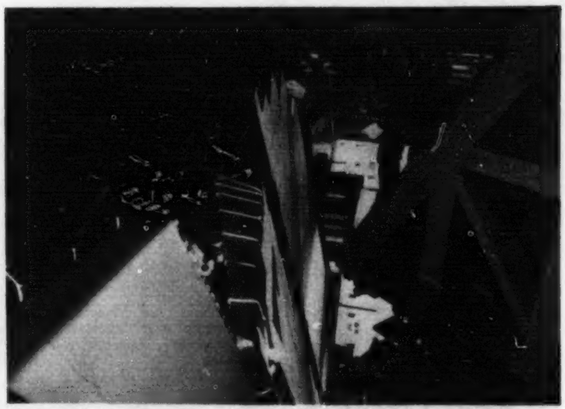
In addition to gap spacing, gap depth also will be controlled through the use of fillers fitted at the bottom of certain gaps; such as at the junction of the tiles and the orbiter fuselage skin. The radii at the outer edges of the tiles will be controlled during fabrication to conform to calculations that show the reduced effects in combination with the spacing. Thermocouples will be fitted to the tile surfaces and at various depths in the gaps to measure temperatures during re-entry. Output of the thermocouples will be recorded on the orbiter's developmental flight instrumentation. To assist in evaluation, tile gap heating effects data will be compared to developmental flight instrumentation data obtained from earlier missions. Principal technologist is W. Pitts, Ames Research Center.

A strong shockwave encompasses the Space Shuttle during atmospheric re-entry which severely compresses and heats the air flowing through it causing molecules to dissociate and react chemically with each other. As the dissociated atomic oxygen approaches the cooler regions of flow adjacent to the orbiter, it fails to recombine into molecular oxygen. The **Catalytic Surface Effects** experiment investigates the chemical reaction caused by impingement of atomic oxygen on the Shuttle thermal protection system which was designed under the assumption that the atomic oxygen would recombine at the thermal protection system wall. This chemical reaction releases additional heat which results in higher thermal protection system temperatures. In this case, the surface is referred to as being a catalytic surface because it allows the chemical reaction to take place. If the thermal protection system surface is non-catalytic, then atomic oxygen will not recombine into molecular oxygen, heating rates will be lowered, and the temperature of the orbiter during re-entry will be lower. With lower temperatures, orbiter thermal protection system weight could be reduced, its flight envelope could be expanded or greater reusability could result.

Catalytic Surface Effects will use baseline tiles, selected from those having developmental flight instrumentation thermocouples located on or near the orbiter lower fuselage centerline. The five tiles will be sprayed with an overcoating mixture of chrome-iron-spinel, a highly efficient catalytic material and a vinyl acetate binder which will protect the overcoat during ground operations. The mixture is compatible with the existing tile and coating and will not alter the thermal or mechanical properties of the uncoated portions of the thermal protection system. During orbiter ascent, the vinyl acetate will burn off the tile surface leaving the chrome-iron-spinel exposed.

Thermocouple measurements recorded during re-entry will be used to determine catalytic surface effects performance. Comparison of this experiment's data with data taken on previous flights from uncoated tiles will aid in the evaluation. At the end of mission, the overcoat will be removed from the five tiles leaving the thermal protection system in its original condition. Principal technologist is D. Stewart, Ames Research Center.

The purpose of the **Dynamic, Acoustic and Thermal Environment** experiment is to predict cargo-bay environments with accuracy and dispatch. These environments are neither constant nor consistent throughout the bay and are influenced by interactions between cargo elements. The experiment's instrumentation includes: accelerometers, microphones, thermocouples, and strain gauges on payloads and in the cargo bay. Sensor outputs will be recorded for post-flight interpretation. NASA's Goddard Space Flight Center, Greenbelt, Md., is responsible for the data reduction. Principal technologist is W. Bangs of Goddard.



Critical Inspection—Doug Joseph, quality inspector with Rockwell International, checks repairs to a thermal protection system tile on Columbia's vertical stabilizer. Over 30,000 tiles cover the body of the spacecraft to protect it from the thermal extremes of temperature encountered during the unique aerospace vehicle's ascent, on-orbit activities and re-entry.

The **Induced Environment Contamination Monitor** also will be making its third trip into space on the fourth flight of Columbia. The desk-sized package will "map" the contaminants around the cargo bay which may affect scientific experiments or other cargo on future flights. The package of 11 instruments developed by NASA's Marshall Space Flight Center, measures any induced atmosphere generated by offgassing and outgassing from materials on board the Shuttle and from other contamination-producing Shuttle activities such as firing the attitude control jets and water dumps. The monitor also provides data on the interaction between the induced and natural environments.

In addition to regular in-place monitoring activities in the orbiter cargo bay during this seven-day flight, the crew will activate the Remote Manipulator System to pick up this package and place it at various locations around the orbiter. During this "mapping" exercise the monitor will employ an instrument added for this mission—the Plume Pressure Gauge—which will measure the pressure wave of the plume emitted by the firing of reaction control jets at the nose of the orbiter. The Induced Environment Contamination Monitor will be attached to a release mechanism (also developed by Marshall) enabling it to be freed and lifted up by the Remote Manipulator System.

The Induced Environment Contamination Monitor operates during pre-launch, ascent, on-orbit, descent, landing and 45 minutes after landing. The on-orbit measurements include molecular return flux, background spectral intensity, molecular deposition and optical surface effects. During other mission phases, dew point, humidity, aerosol content and trace gas will be measured.

Other experiments making their second trip into space include the Nighttime/Daytime Optical Survey of Lightning, flown aboard the second mission but produced limited results because of the shortened mission, and the Monodisperse Latex Reactor, a Shuttle Flight 3 passenger.

The **Nighttime/Daytime Optical Survey of Lightning** experiment is designed to record motion pictures and photo-cell readings of lightning and thunderstorms as seen from orbit. The lightning survey experiment concept was conceived by Principal

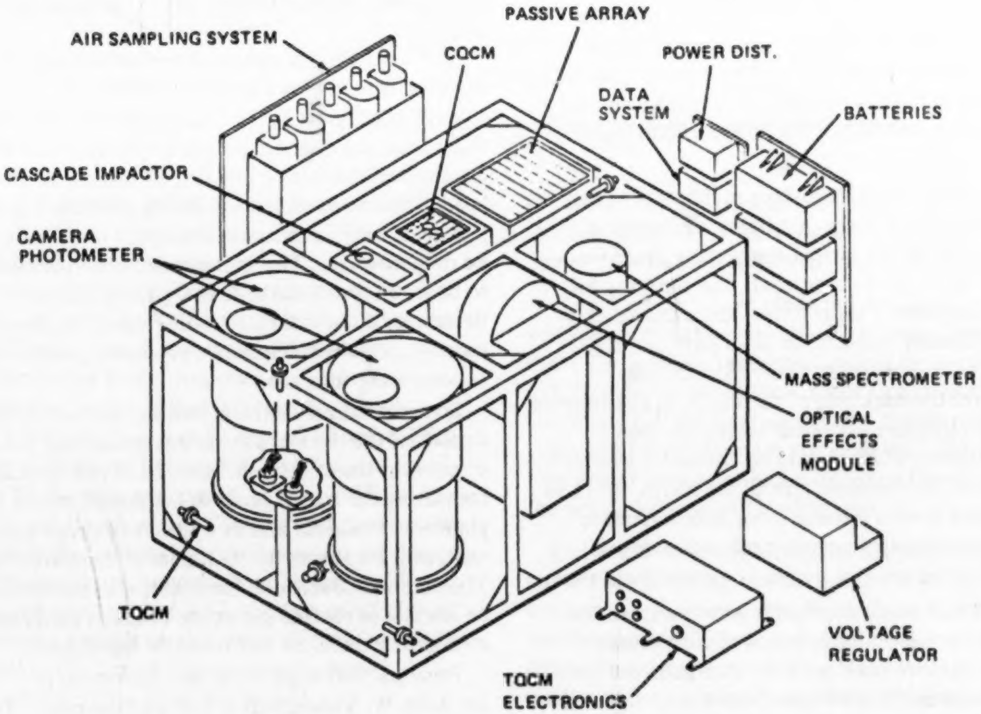


Diagram of the Induced Environment Contamination Monitor carried aboard the fourth Shuttle mission. The package will "map" the contaminants around the cargo bay which may affect scientific experiments.

Investigator Dr. Bernard Vonnegut of the State University of New York, Albany.

The experiment, to be conducted from the orbiter crew compartment, consists of a 16-mm data acquisition camera synchronized with a two-channel stereo cassette recorder receiving the output of a photocell optical system serving as a sensor. The camera-sensor system was built for Marshall by Johnson Space Center. The Shuttle astronauts will use the motion picture camera to film the lightning flashes of thunderstorms. A diffraction grating will be attached to the camera lens during nighttime observations to provide lightning spectrographs. This data can be used to determine the temperature, pressure, molecular species, electron density and percent of ionization in the lightning's path.

Lightning discharges will be sensed by the photo-optical system, which creates an electronic pulse in response to the detection of a lightning flash. These pulses will be recorded on magnetic tape. A lightning event, visible as only one flash, is usually composed of many separate discharges or strokes which are detected by the photocell. Thus the photocell also will be used during the night to record lightning strokes. The motion picture camera will be used during the day as well to film the cloud structure and the convective circulation in the storm. These techniques may be adaptable in the development of sensors to identify severe weather situations from future meteorlogical satellites.

The area of the Earth's surface in the view of the orbiting Shuttle is so large that lightning storms will probably be visible on almost every orbit. Because of the high speed of the spacecraft, these storms will remain in view only a short time—just a few seconds for storms directly beneath the flight path and somewhat longer for those off to either side. During passages over the dark side of the Earth, the astronauts will readily recognize nocturnal storms by their lightning flashers which should be visible for hundreds of kilometers. On the sunlit side of the Earth, the crew will recognize storms through prior familiarization with the appearance of cumulonimbus clouds and associated characteristics shapes as viewed from above.

During the mission, the Shuttle astronauts will be radioed meteorlogical information to alert them to possible storm locations based on data gathered by NASA's Marshall Space Flight Center targeting team using the Man Computer Interactive Data Access System located at the Space Sciences Laboratory. This system is a NASA/NOAA sponsored system based at the University of Wisconsin, Madison, which furnished the Marshall team and other research groups with a mix of vast amounts of ground data and satellite weather information.

The second flight on the **Monodisperse Latex Reactor,** a materials processing in space experiment, is designed to test the feasibility of making large size monodisperse (same size) polystyrene latex microspheres using the products of the third Space Shuttle mission as seed particles. The latex spheres are used in calibration of scientific and industrial equipment and have potential medical and research applications.

The experiment consists of four, one-foot-tall reactors, each containing a chemical latex-forming recipe, housed in a two-foot-tall metal cylinder. The recipe is a suspension of very tiny latex beads in water or another liquid. Prior to launch, each of the reactors is loaded with 100 cc's of the chemical latex-forming recipe. A small onboard computer will control the experiment after the Shuttle crew turns it on. In orbit, the latex mixture is heated to a constant 70-degree Centigradewhich initiates a chemical reaction to form the larger plastic beads. A recorder will store all data produced during operation of the experiment. After 20 hours, the experiment will turn itself off.

The latex reactor operated perfectly during the third mission, running for 14 hours and making controlled quantities of beads in sizes up to five microns. On flight four, the experiment will be operated for 20 hours to enhance the capability of making larger monodisperse particles. On Earth, particles can be produced only up to about 3 microns in size and still be monodisperse. This experiment, which is scheduled to be flown on a total of four flights, will help determine if much larger (more than 20 microns) monodisperse spheres can be produced practically and economically in space.

Some of the medical and industrial research applications of the latex beads include measuring the size of pores in the wall of the intestine in cancer research; measuring the size of pores in the human eye in glaucoma research; and as a carrier of drugs and radioactive isotopes for treatment of cancerous tumors. The National Bureau of Standards also has indicated an interest in routine use of the beads as calibration standards in medical and scientific equipment.

Principal investigator on the experiment is Dr. John W. Vanderhoff of Lehigh University. The three co-investigators are Drs. Fortunato J. Micale and Mohamed S. El-Aasser of Lehigh University, and Dale M. Kornfeld of Marshall Space Flight Center.

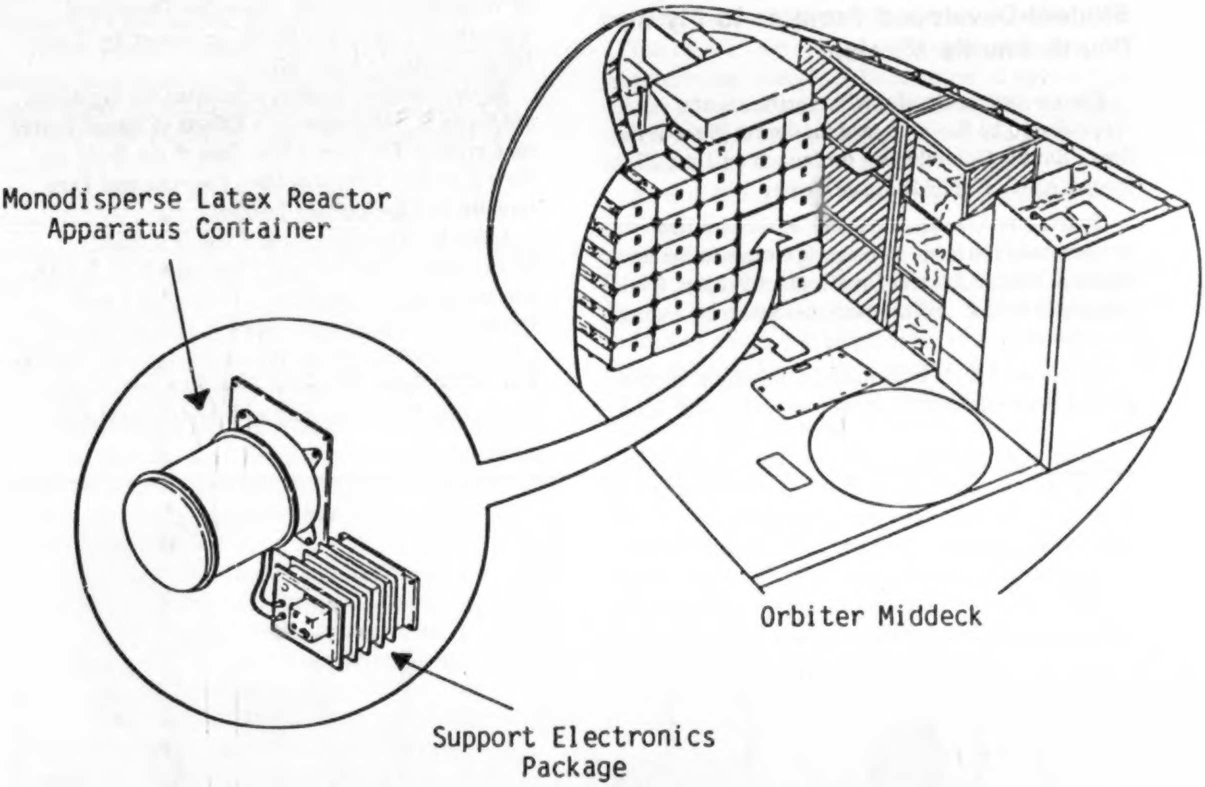

Monodisperse Latex Reactor Apparatus Container
Orbiter Middeck
Support Electronics Package

Diagram showing placement of a materials processing in space experiment, the **Monodisperse Latex Reactor,** carried aboard Shuttle Flight Four.

Aboard Columbia for the third mission was the first student-developed experiment, and NASA will continue its **Shuttle Student Involvement Project** on the fourth flight with two additional student experiments from this project slated to fly on Columbia. They are: **Effect of Space Travel on Levels of Trivalent Chromium in the Body,** proposed by **Karla R. Hauersperger,** senior at East Mecklenburg High School, Charlotte, N.C.; and **Effect of Exercise, Diet and Zero Gravity on Lipoprotein Profiles,** proposed by **Amy M. Kusske,** sophomore at Wilson High School, Long Beach, Calif. These two studies involve the physiological effects of space travel on the human body. Neither experiment will require any hardware. Instead, the astronauts will fill out data cards about their exercise periods on the treadmill and their daily food intake. (For more information on these experiments see page 12 of this issue.)

The fourth flight of Columbia is scheduled to last 169 hours with 113 orbits around the Earth. Mattingly and Hartsfield will follow the same course in returning from orbit as did other Shuttle crews: retrofire over the Indian Ocean, atmosphere entry over the western Pacific Ocean, and then a transition to aerodynamic controls in the atmosphere to land as an aircraft.

NASA officials have made the auto land and cross-wind landing highly desirable flight objectives on this flight. Columbia is scheduled to land on runway 17 at Edwards Air Force Base, Calif., a dry lakebed, on Runway 22, a hardsurface runway if acceptable cross-wind conditions are not available. The 3-mile-long paved runway at Kennedy Space Center will be the prime contingency landing site.

Columbia will be guided to its landing site by a microwave scanning beam landing system on the landing site. As the orbiter descends, Mattingly will put the spacecraft through rolls and other maneuvers to test how the spacecraft handles under stress. The vehicle will remain in the automatic mode through touchdown and rollout.

Student-Developed Projects to Fly on Fourth Shuttle Mission

Eleven student-developed experiments are scheduled to be flown aboard the fourth flight of the Space Shuttle Columbia set for launch on June 27 from NASA's Kennedy Space Center, Fla.

Two of these projects are high school student projects selected from 10 winning entries in the first National Shuttle Student Involvement Project, a joint venture of NASA and the National Science Teachers Association.

On the third flight of Columbia in March, another project from this same competition was flown: Effects of Weightlessness on the Honeybee Drone and Velvetbean Caterpillar Moth, developed by Todd Nelson of Rose Creek, Minn.

Student project winners scheduled for flight four are Karla R. Hauersperger's **Effects of Space Travel on Levels of Trivalent Chromium in the Body** and Amy Kusske's **Effects of Diet, Exercise and Zero Gravity on Lipotprotein Profiles.**

Karla R. Hauersperger is a senior at East Mecklenburg High School, Charlotte, N.C. NASA consultant on her project is Dr. Carolyn Leach, Biomedical Laboratories Branch, Johnson Space Center, Houston; her corporate sponsor, Dr. George Van B. Cochran, President, The Explorers Club, New York, N.Y.; assisting with Shuttle payload

Emergency Walk-Through—Shuttle Flight 4 prime crew commander Ken Mattingly (second right) and pilot Henry Hartsfield (far left) do a walk-through of an emergency escape program which might be implemented in the event of a fire at Kennedy's Launch Pad 39A. Launch pad emergency exit basket and slide wire are in background at right.

integration are Chris Perner and John Jackson of Johnson's Crew Station Integration Section.

Hauersperger's research goal is to determine if any alternations occur in chromium metabolism during space flight. As background to her experiment, she presents three known factors: (1) serum levels of insulin are known to change slightly during space flight; (2) insulin helps control body use of carbohydrates; (3) chromium is a cofactor (that is, a substance which must be present in low quantities for an enzyme to work) for insulin.

Her experiment requires a two-part methodology: a record of crew diets from seven days before launch until landing and measurements of crew levels of serum glucose, insulin, chromium and urine chromium. Blood and urine samples will be collected from the crew during scheduled physical examinations on the seventh and second day before launch and on landing day. Blood and urine samples are normally taken on these days.

Analyses of these samples will be done by the Johnson Space Center Biochemical Laboratories and results will be provided to Hauersperger for interpretation. Trivalent chromium will be determined by atomic absorption spectrophotometry.

Amy Kusske is a sophomore at Wilson High School, Long Beach, Calif. NASA consultant and payload integration specialists for her project are the same individuals assisting Karla Hauersperger: Dr. Carolyn Leach, Johnson Space Center, and Chris Perner and John Jackson, respectively, also of Johnson. Kusske's corporate sponsor is William K. Douglas of McDonnell Douglas Astronautics Co., Huntington Beach, Calif.

Kusske's project goal is to determine whether any alterations occur in lipoprotien profiles during space flight. As background to her experiment she presents four key elements: (1) atherosclerosis and coronary artery disease are diseases of epidemic proportions in the United States; (2) people with coronary artery disease are more liable to have heart attacks; (3) several different types of lipoproteins are found in the blood. (The ratio between different types of lipoproteins (particularly high density lipoproteins to low density lipoproteins) can be used to predict the likelihood of someone developing atherosclerosis.); (4) exercise increases the high density lipoprotein/low density lipoprotein ratio, thereby decreasing the risk factor for atherosclerosis and coronary artery disease.

Her project requires a three part methodology: recording crew diets from seven days before launch through landing day; measuring crew lipoprotein profiles, and recording crew physical exercise.

The crew's food content for both experiments will be determined using U.S. Department of Agriculture computerized reference values. During flight, the crew will record on log cards how much they eat of what foods.

As with Karla's experiment, blood samples will be collected from the crew during scheduled physical examinations around seven and two days before launch and on landing day. Analyses of these samples also will be done by Johnson's Biochemical Laboratories and results will be provided to Amy for interpretation. Lipoprotein profiles will be determined by electrophoresis. The crew will record on log cards the time, type and duration of exercise.

The other student-developed experiments to be flown aboard the fourth flight of Columbia in June will be placed within a **"Getaway Special"** 5-cubic-foot payload canister. This payload, consisting of the nine experiments, was purchased by Gilbert Moore of Thiokol Corp., Ogden, Utah and donated to Utah State University where it is being used as a program for student-developed experiments.

Getaway Specials, officially titled "Small Self-Contained Payloads," is a program offered by NASA to provide an opportunity to anyone who wishes to fly a scientific or technological project aboard the Space Shuttle. The canisters come in three sizes with the flight fees varying per size: 5 cubic foot, maximum weight of 200 pounds; 2½ cubic foot, up to 100 lbs., and 2½ cubic foot, up to 60 lbs. Prices are $10,000, $5,000 and $3,000 respectively. There are no stringent requirements to qualify for space flight but the payload must meet certain safety criteria.

Getaway Specials are flown on Shuttle missions on a space available basis. Since the offer for Shuttle space was first made in 1976, more than 376 reservations have been made by more than 197 individuals and groups from 33 states, the District of Columbia and 14 foreign nations.

The following nine Utah State experiments scheduled for flight four represent the first private sector payload to be flown as a Getaway Special.

Drosophilia Melanogaster (Fruit Fly) Growth Experiment. Student Investigator: Walt L. Moore, HDR Sciences Co., Santa Barbara, Calif., graduate student/environmental sciences.

This experiment is designed to provide a means of raising and separating succeeding generations of fruit flies in orbit to study the effects of micro-gravity on their genetic structure. This will be a test of equipment that is proposed to be flown on the Long Duration Exposure Facility, scheduled for launch in 1984.

Artemia (Brine Shrimp) Growth Experiment. Student Investigator: Bruce W. Moore, Weber State College, Ogden, freshman/music major.

The brine shrimp Artemia will be flown to determine the genetic effects of micro-gravity on cysts hatched in space. Cysts will be injected into a saline solution upon experiment activation. The growing shrimp, called nauplii, will be observed during the remainder of the flight with a 35-mm motordriven Nikon camera with a 55-mm micro-Nikkor lens. The camera will be shared between this experiment and another experiment concerning observations of Duckeed growth in micro-gravity. Powdered rice hulls will be fed to the shrimp by a linear actuator. The shrimp will be studied post-flight by means of electron microscopy.

Surface Tension Experiment. Student Investigator: James Elwell, Utah State University, Ogden, graduate student/electrical engineering.

The goal is to study the shape of a liquid meniscus in a weightless environment. An aluminum block contains several holes filled with solder. Upon entering weightlessness, the block is heated, allowing the solder to flow and assume a meniscus (crescent-like) shape. The block is allowed to cool, "freezing" the meniscus when the solder solidifies.

Composite Curing Experiment. Student Investigator: Amber M. Dalley, Utah State University, Ogden, senior/math-philosophy major.

This experiment will complete the cure of a B-staged (partially cured) epoxy resin-graphite composite sample in microgravity. The composite sample will be heated to 163 degrees C and maintained at that temperature for one-half hour to allow the resin to gel. The flight sample will be compared with samples processed in one g, and post-flight laboratory analysis will determine the quality of wetting between the resin and the graphite fibers and test the tensile strength of the sample.

Thermal Conductivity Experiment. Student Investigator: Russel R. Laher, Utah State University, Ogden, junior/physics-geology major.

An oil and water mixture in a one g environment will separate due to the density difference. The goal of the experiment is to carry oil and water into orbit and mix the two, then heat the mixture with a platinum wire. Temperatures of the heater wire, the mixture, and the air around the cylinder will be monitored. Ultimately, the thermal conductivity of the mixture will be calculated from these data.

Micro-Gravity Soldering Experiment. Student Investigator: G. Christian Alford, Utah State University, Ogden, senior/electrical engineering major.

The Micro-Gravity Soldering Experiment studies the separation of flux from solder while soldering in weightlessness. The lack of buoyancy in a non-accelerating environment could allow pockets of flux to become trapped in the solder. The experiment will melt samples of resin core and coreless solder on four heated copper foils. When the experiment is returned, the solder will be analyzed for trapped pockets of flux and compared with solder similarly processed on Earth.

Root Growth of Lemna Minor L. (Duckweed) in Micro-Gravity. Student Investigator: Kelly D. Hunt, Utah State University, Ogden, junior/physics major.

Using the 35-mm Nikon, shared with the brine shrimp experiment described earlier, this experiment will photograph the root growth patterns of Lemna Minor L. (Duckweed). The investigation centers on the nutrient transport role played by sieve tubes in the plants' roots in response to the force of gravity in Earth-grown specimens. The plants will be injected with a fixing agent before experiment deactivation. Electron microscopy will be used to compare control and flight specimens.

Homogeneous Alloy Experiment. Student Investigator: Terrance L. Thomas, Utah State University, Ogden, junior/electrical engineering.

An aluminum chamber containing a powdered bismuth-tin mixture will be placed into Earth orbit. The chamber will be heated, passing the melting points of the chemicals and allowing formation of an alloy to take place. The chamber will cool down and the alloy will be returned for Earth-based analysis.

Algal Micro-Gravity Bioassay Experiment. Student Investigator: Steven M. Walker, Utah State University, Ogden, senior/biology major.

The goal of the experiment is to monitor the growth rate of Chlorella vulgaris, a unicellular green algae, in micro-gravity. Upon experiment activation, a freeze-dried sample of algae will be injected into the media-filled growth chamber. Over the duration of the experiment the culture optical density and temperature will be measured. Near the end of this experiment, a fixative will be injected into the chamber preserving the cells for post-flight analysis.

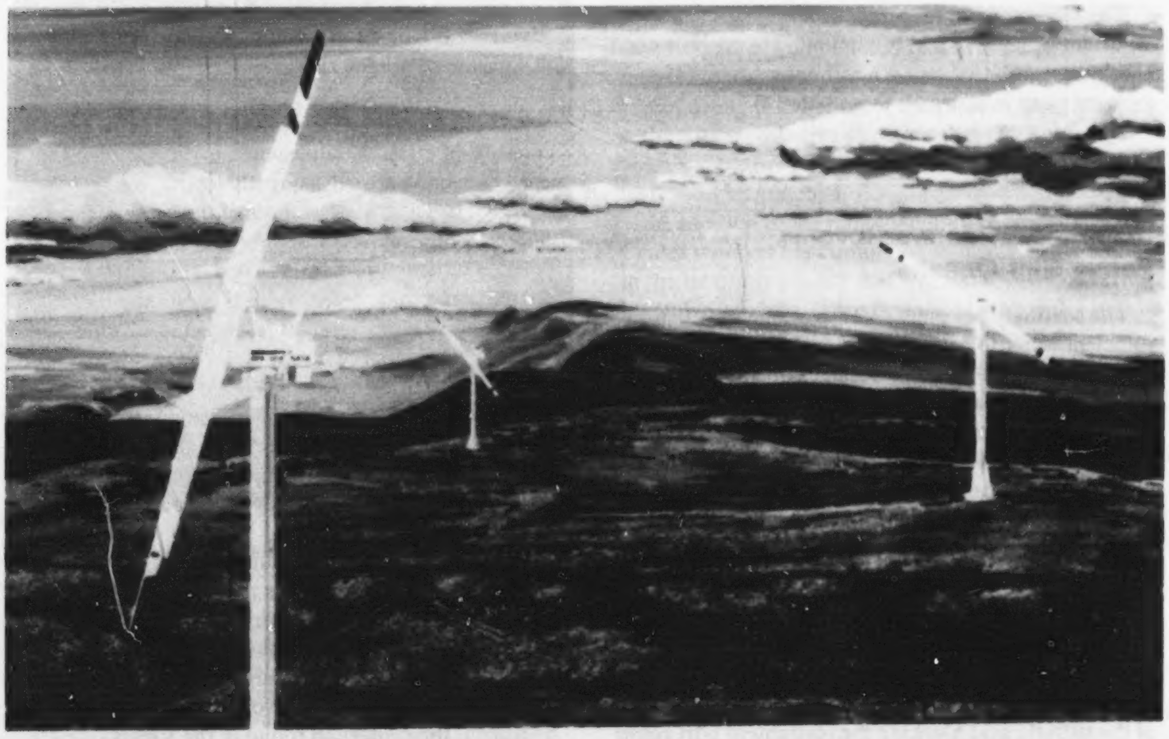
Nation's First Large Wind Turbine Cluster in Full Operation

Three of the world's largest wind turbines are now working together for the first time in the nation's only multi-megawatt wind turbine cluster. The Mod-2 wind turbines, located at Goodnoe Hills, Wash., together will generate enough electricity to serve approximately 2,000 average homes. Each turbine is rated at 2,500 kw. This cluster of wind turbines are currently the most advanced in a series of experimental horizontal-axis machines developed in a program sponsored by the Department of Energy and managed by NASA's Lewis Research Center, Cleveland.

The three machines were dedicated in May 1981. Unit No. 1, however, had been shut down since last summer when a failure occurred in the control system during a simulated emergency shutdown test of the machine causing damage to its electrical generator and power train. The nation's largest multi-megawatt wind farm now is back in full cluster operation. Testing and research investigations are underway in the areas of aerodynamics, structural dynamics, materials and multiple systems interactions.

Each wind turbine stands 61 meters (200 feet) above the ground (hub height), with the rotor blades measuring 91 m (300 feet)—the length of a football field—from tip to tip. The Mod-2s are designed to begin producing power in winds of 23 kilometers per hour (14 miles per hour)—measured at the machine's hub height—and reach rated power output in winds of 45 km/hr (28 mph). When wind speeds exceed 72 km/hr (45 mph), the blade tips automatically feather, shutting down the system. Winds at the Goodnoe Hills site average 27 km/hr (16½ mph) and blow between 23 and 72 km/hr (14 and 45 mph) about 60 percent of the time.

The second generation Mod-2s were built on a technology base developed by research and testing on smaller first generation wind turbines. Tests on the four 200 kW, Mod-OA wind turbines located in New Mexico, Puerto Rico, Rhode Island and Hawaii are now nearing completion. The Mod-OA wind turbines were designed to obtain early operation and performance data while gaining initial operating



Artist concept of the world's largest wind turbine cluster in Goodnoe Hills, Wash., which together generate enough electricityto service 2,000 average homes.

experience in existing utility systems. Since the first installation in 1977, these machines have accumulated more than 36,000 hours of operation, and generated more than 3,500,000 kWh of energy.

In addition, a scaled-up machine similar to the Mod-OA, designated as the Mod-1 2,000 kW wind turbine, located in Boone, N.C., demonstrated that electric power produced by a megawatt-size wind turbine could be successfully fed into a utility grid, and verified the design approach used on large wind turbines. These early machines were experimental and not expected to be cost effective. However, their operating experience and performance characteristics have had a significant effect on the design of the second generation Mod-2 machines developed under the Federal Wind Energy Program.

The Mod-2 wind turbines were designed, manufactured and erected by the Boeing Engineering and Construction Co., Seattle. The Bonneville Power Administration provided the site and constructed the substation and power system facilities. Bonneville also will take power from the experimental turbines and feed it into the northwest power grid for use by regional utilities.

The Department of Energy, through national laboratories and NASA, is continuing to support wind energy research to develop a technology base for a growing wind industry.

Scientific Evidence Reveals Venus Had Oceans

The searingly hot planet Venus at one time had sufficient water to have possibly had oceans 30 percent or more the size of Earth's oceans, concludes University of Michigan atmospheric scientist, Dr. Thomas M. Donahue. Donahue, one of NASA's Pioneer Venus interdisciplinary scientists, and colleagues have pieced together data obtained during the descent of the Pioneer Venus Large Probe into the yellow planet's lower atmosphere which supports this theory.

The port to the large probe's mass spectrometer became coated with sulfuric acid droplets from Venus' clouds and reliable measurements were not expected to result while the port was clogged.

Donahue and fellow investigators believed analysis of the sulfuric acid blocking the instrument port could contain sufficient traces of Venus water to permit determination of the current ratio of deuterium (heavy hydrogen) to hydrogen. Because of the different rates of escape of light hydrogen (H) and heavy hydrogen (D) over geologic time, determination of the current deuterium/hydrogen ratio would provide the atmospheric scientists with indications of whether Venus has always lacked water or whether large amounts of water were present early in the planet's evolution but were subsequently lost.

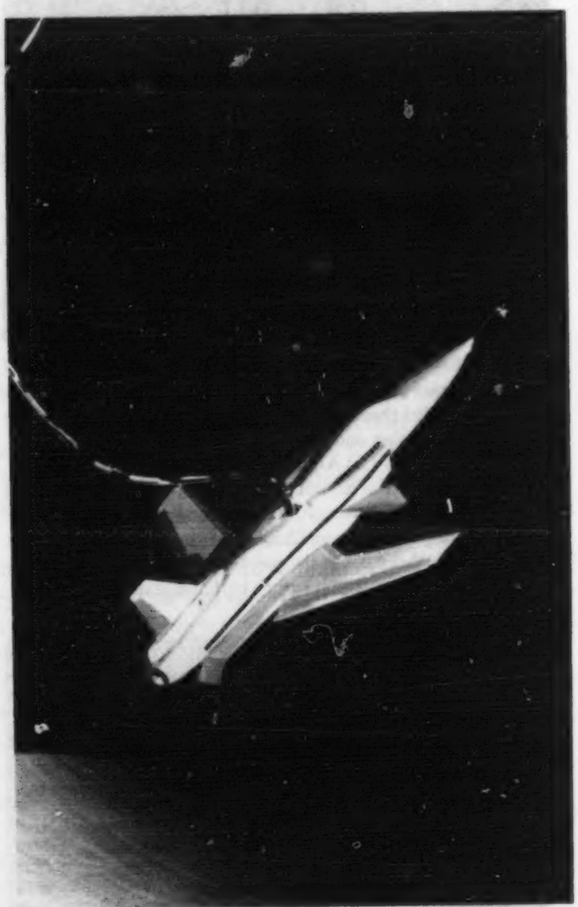
Recent view of Venus taken by the Pioneer spacecraft in orbit around the planet until 1986.

Based on their data analysis of the probe's sulfuric acid droplets, Donahue and his colleagues postulate that the present ratio of deuterium to hydrogen on Venus is on the order of 1.6 x 10 (to minus 2 power). This current ratio coupled with additional estimates of the original ratio of deuterium to hydrogen on Venus—estimated to be close to that originally on Earth, or 1.5 x 10 (to minus 4 power)—have led Donahue and colleagues to suggest that originally Venus had an ocean which was lost as a result of hydrodynamic outflowing of hydrogen.

Following a large initial outgassing of water from the planet, Donahue suggests that a runaway greenhouse condition ensued which drove hydrogen from the liquid ocean into the atmosphere from which it subsequently left through supersonic hydrodynamic escape. Since this process favors the escape of hydrogen, the deuterium found in the Venus atmosphere today is an observable remnant of the early Venus ocean.

Donahue and his colleagues suggest the minimum amount of water lost from Venus was the equivalent of one third of Earth's oceans, although it could have been more.

These findings present intriguing possibilities for future exploration of the cloud-shrouded planet. NASA is currently studying a radar mapping mission to Venus which could provide topographical evidence of early river channels and oceans.



Wind Tunnel Testing at Langley—At left a new radical wing design undergoes wind tunnel testing at NASA's Langley Research Center, Hampton, Va. This one-sixth scale model of the experimental X-29A is the subject of a research program managed by the Defense Advanced Research Projects Agency. The model is flown by remote control to study low-speed stability and control characteristics. Compressed air, supplied by an attached hose and computer and other control tests allow engineer pilots to simulate actual scaled flight. Findings from Langley's testing are helping to develop the full-scale prototype model by Grumman Aerospace Corp., scheduled for flight tests in 1984.

Spacelab Experiment Installation Begun

Installation of experiments on the Spacelab 1 pallet has begun at NASA's Kennedy Space Center, Fla., in preparation for the first flight of the reusable scientific laboratory in September 1983.

Spacelab, a versatile, on-orbit research facility developed for NASA by the European Space Agency (ESA), and funded by its member states, will be carried in the cargo bay of the Space Shuttle orbiter. Configuration for the first flight, a joint NASA/ESA sponsored mission, will consist of a habitable module in which scientists will work, and a pallet which will support experiments requiring direct exposure to space.

NASA's Marshall Space Flight Center, Huntsville, Ala., is responsible for monitoring the laboratory's development and for managing the first three missions. Actual installation of experiments and preparation of the laboratory for launch is being done at Kennedy.

Thus far all structural attach points have been installed on the pallet and installation has begun of the high voltage power supply for the Space Experiments with Particle Accelerators (SEPAC) payload. This payload is a Marshall sponsored experiment series that will study interactions of the Earth's magnetosphere and upper atmosphere.

Following installation of the power supply, the orthogrid, a table-like structure that will hold NASA-sponsored pallet-mounted experiment hardware, will be attached.

In addition to the pallet integration work, Space Center workers are continuing to install experiments in the laboratory racks that will be carried inside the habitable module. Once integrated, the racks will be hooked together and slipped into the module as a unit. NASA's Johnson Space Center, Houston, Life Sciences Mini-lab, a double rack of biology experiments, has been transferred from its ground test to its flight rack, and has been checked out. Three other racks are presently being integrated. One will contain control and display panels for SEPAC, Atmospheric Emission Photometric Imaging and Imaging Spectrometric Observatory hardware.

The first two are space plasma physics experiments and the third is an investigation in the field of atmospheric physics and Earth observations. Another rack will hold a data display unit, video instrumentation recorder, and a package of tribiological experiments which will study lubrication in zero gravity. The third rack will contain storage compartments.

Space Techniques Separate Paintings Hidden Beneath Master Works

Space scientists at NASA's Jet Propulsion Laboratory, Pasadena, Calif., working with art conservators at the Los Angeles County Museum of Art, have developed a new technique for separating paintings hidden beneath master works. The effort resulted in the first successful use of image enhancement techniques to separate X-ray images of paintings where two or more works exist on the same surface.

The technique, derived from computer-processing of photographs from NASA's unmanned spacecraft, will allow art conservators and museum curators to better evaluate earlier compositions often found underneath easel paintings.

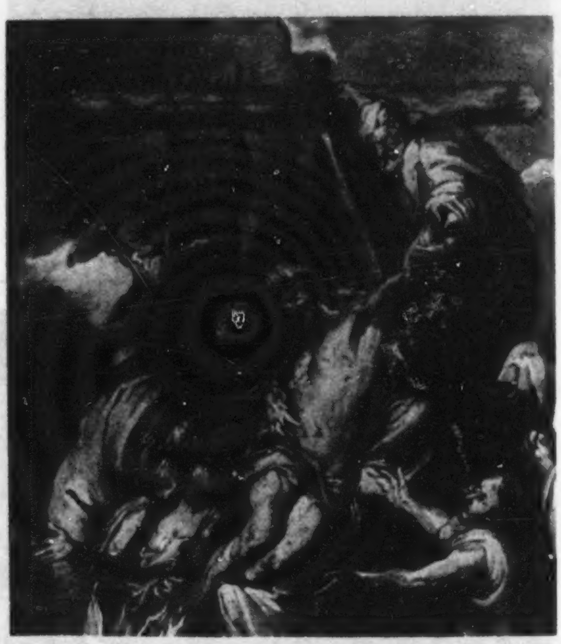
William R. Leisher, head of conservation at the Los Angeles County Museum of Art, asked NASA's Jet Propulsion Laboratory investigators to separate and enhance a painting found to exist beneath the 17th century oil painting "The Crucifixion," by an unidentified Flemish painter.

Astronomer Dave Glackin and scientist Don Lynn, both image processing specialists, and computer analyst Raim Quiros, in collaboration with Jim Druzik and Dr. Pieter Meyers of the museum, developed computer programs for subtracting the top painting from the bottom, so that the hidden painting may be seen in detail.

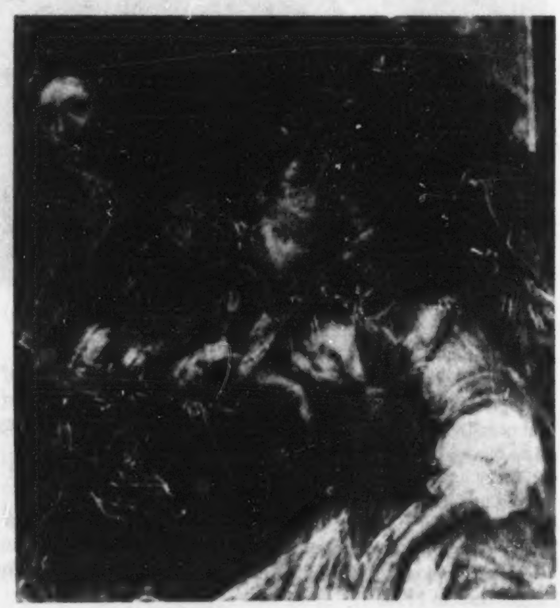
"The Crucifixion," painted on paper, shows Jesus Christ being lowered from the cross by a group of followers. The bottom painting, directly on the 16 by 24-inch wooden panel, shows a scene of a man and a woman seated at a table. The two are dressed in 17th century clothing, and the room is lighted by sunlight shining through a window.

Art conservators commonly use X-ray photography to examine paintings. The X-ray photos may often show that paintings or sketches exist beneath a top painting, but the works are not automatically delineated. The two works usually are fused in an X-ray photo and appear as a blurred, double image.

"What we sometimes find is a completely different composition underneath," said Druzik, associate conservator at the museum. When that happens, he said, "there will always be a question in the curator's mind as to whether or not an unknown masterpiece exists under the top painting layer."



The Crucifixion, a 17th century oil painting by an unknown Flemish artist was painted over another completely different work as revealed through X-radiographic photography and computer processing completed by NASA's Jet Propulsion Laboratory and the Los Angeles County Museum of Art. The new image separation technique was developed from computer processing photgraphs from NASA's unmanned spacecraft. Painting at top shows Jesus Christ being lowered from the cross; beneath this work is the painting revealed in the bottom image: two figures in 17th century clothing seated at a table.



In order to separate the two images, NASA's Jet Propulsion Laboratory team first designed computer programs to minimize the appearance of the grain patterns of the wood on which the original work was painted. Next, a photograph of the top painting was matched with the X-ray image. Any brush strokes from the X-ray version that matched the top painting were subtracted. Consequent subtractions removed most traces of the top painting, while the remaining was computer-enhanced to bring out detail.

The pioneering development of the painting subtraction technique could lead to future systems designed uniquely for discerning and separating multiple X-ray images of paintings with designs under the surface. Such systems, said Druzik, "will be another invaluable tool for conservators and curators."

"This project is a good example of the applications of space technology to other problems of great public interest," said Dave Glackin. Glackin and Kurt Liewer, both of NASA's Jet Propulsion Laboratory, working with museum conservators, are undertaking a new task: using a high-resolution spacecraft photography system and the laboratory's image processing facility to study the condition of the museum's "Codex Hammer" by Leonardo da Vinci. Results from the project, supported by a grant from the Armand Hammer Foundation, should determine how to best preserve the works.

Future applications of computer processing to art conservation might include techniques to date paintings by determining the age of wood on which compositions were painted. Dendrochronology, the science of dating wood based on the number and character of tree rings, usually requires shaving wood away from the edge of the original wood panel. Computer enhancement of the wood grain of a panel would eliminate the need to remove original support material in order to date it.

The $35,000 painting subtraction project was funded by Caltech President's Fund. NASA's Jet Propulsion Laboratory, Pasadena, is operated for NASA by the California Institute of Technology.

Electric Rocket Engine Completes 11 Years in Space

An 11-year space journey by SERT II has proven that solar-powered, ion-electric rocket engines are an efficient and reliable new type of space propulsion. SERT II (for Space Electric Rocket Test II) is the second in a series of these experimental engines to be developed and built at NASA's Lewis Research Center, Cleveland.

Launched Feb. 4, 1970 from Cleveland, SERT II had traveled 1.6 billion miles and had circled the Earth 56,143 times when contact between it and the ground was cut off on June 5, 1981. This rocket engine operated for some 100,000 hours during its lengthy space journey, executed more than 6,000 commands sent up from the Lewis ground station, and transmitted 5 billion bits of information over a period of 40,000 hours. Much useful information on the long-term operation of thruster components, power supplies and solar arrays also was obtained.

In its long flight, SERT II traveled in a circular polar orbit in which the vehicle passed over both the North and South poles, allowing it to remain in total sunlight during a complete orbit.

The ion robot propulsion system is expected to be used for energetic missions including comet and asteroid rendezvous, exploration of the outer planets, as well as for Earth-orbital applications such as station-keeping of communications satellites and orbital platforms.

The SERT II type propulsion system differs from the more familiar Space Shuttle chemical propulsion systems. The Shuttle engines develop tremendous thrusts by releasing the energy stored in chemical reactions. The electric rocket engine is called an ion thruster because the thrust of the engine is produced through the rapid, controlled discharge of ions created by the ionization of atoms of the fuel supply. Though several elements make efficient fuels, the SERT II program used liquid mercury. In operation, solar cells convert sunlight into electricity which is then converted from 80 v. dc in the power conditioning unit. With this electric power, mercury atoms are bombarded with free electrons, which knocks one electron off each mercury atom to produce what is called ionized mercury; that is, positively charged mercury atoms. Thus electrified, the ions mix with other electrons to form a plasma, which is a group of very hot gases capable of conducting electricity.

A magnetic field set up between two metal screens at the aft end of the engine draws the positively charged ions from the plasma and accelerates them at very high exit speeds out of the engine. This creates a high velocity ion beam for efficient thrust. Electrons are injected into this beam, producing a neutralized gas that subsequently drifts out harmlessly into space. While the ion rocket engine thrust level is much less than chemical rockets it can provide years of low level thrust.

SERT II weighed 1,500 kilograms (3,300 pounds). Its main body was 6 meters (20 feet) long and 1.5 m (5 ft. in diameter, and two 15-cm (5.9 in.) diameter electric rocket engines were positioned at one end of the craft. At the other end, two 7.6-m (25-ft.)-long by 1.5-m (5-ft.)-wide solar cell arrays were spread to capture and convert sunlight into the electricity needed to operate the experimental engines and other onboard equipment.

The next space test of an ion rocket engine will take place in 1983. Two small ion rocket engines, each 8-cm (3-in.) diameter, will be tested for more than two years in space. These engines, called IAPS for Ion Auxiliary Propulsion System, were designed by Lewis engineers and are built by the Hughes Research Laboratories. If the engines test successfully, they will be used on communications satellites to greatly increase their lifetime.

More powerful versions of the ion rocket engine, 30-cm (11.8 in.) in diameter, have received much Earthbound testing while the SERT II engines were being tested in space. Designs for engines were turned over to NASA's Marshall Space Flight Center, Huntsville, Ala., for use as the main, in-space propulsion for spacecraft. Funding limitations have prevented the actual use of these large engines, but they hold great promise to become the space propulsion rocket system of the future.

Invented and first demonstrated at the Lewis Center in 1958 by Dr. Harold R. Kaufman, the first mercury-fueled electric rocket engine was proved feasible in a SERT I ballistic space flight that lasted only 50 minutes. That brief flight proved that mercury-produced ion beams could be successfully neutralized in space. In the following years, engineers worked to improve and retune the engine's technology.

Chocolate Tribute to Shuttle Flight 3—Chocolatier Marcel Antoine and wife Suzanne, of Hackettstown, N.J., honored the third flight of Columbia in their own unique way—by sculpting a 75-lb. chocolate replica of the spacecraft. Chocolate Columbia was the focus of Marcel's 19th annual Easter confectionery display at his candy shop in Hackettstown. Measuring 47 inches tall and 33 inches wide, Marcel perched 5-inch tall candy figures of astronauts Lousma and Fullerton on ladders inside the cargo bay which was bedecked with American flags and miniature Easter chickens and eggs for companions. The chocolate Shuttle was melted down soon after Easter.

Upper Stage Rocket Begins Checkout at KSC

With the first operational flight of the Space Shuttle imminent, one of the major elements to be used in the operational phase has begun checkout at Kennedy Space Center.

The Inertial Upper Stage (IUS) pathfinder vehicle began fit testing and electrical checkout at KSC in April. The inert stage substitutes for an actual transfer vehicle designed to boost heavy payloads from low earth orbit to operating altitudes.

Checkout includes installing the pathfinder vehicle in the payload canister, or portable white room, which will move the IUS/satellite combinations from assembly and processing facilities to the launch pad, and handling tests within the Payload Changeout Room at the pad.

Using a pair of solid rocket motors, the stage will be capable of boosting satellites weighing more than 2,000 kilograms (4,409 pounds) into geosynchronous orbit. The rocket motors can be tailored to specific power levels to custom-fit the IUS to particular mission requirements.

Unlike the single-stage Payload Assist Module (PAM) used for lighter payloads, the IUS is not spin stabilized. An inertial guidance system in the IUS allows bulky, non-spinnable payloads to be boosted while retaining the simplicity and reliability of solid rocket design.

The design concept allows IUS to do double duty by being usable aboard the Space Shuttle as well as the Air Force's uprated Titan 34-D expendable rocket. Similarly, the PAM can be used with Space Shuttle or aboard NASA's veteran Delta booster.

The first actual use of the IUS aboard the Space Shuttle is planned to be during STS-6 (also the maiden flight of the orbiter Challenger), and the payload will be the first of two Tracking and Data Relay Satellites (TDRS). Future uses will include the second TDRS spacecraft, heavy satellites of the INTELSAT class, with possible uses with Department of Defense payloads and planned interplanetary probes such as the Galileo mission to Jupiter under discussion.

The Space Division of the Air Force Systems Command, developer of the IUS, has awarded a contract to Boeing Aerospace Company for construction of nine IUS flight vehicles to be used during the 1980s.

Inspector General Activities

NASA's Office of the Inspector General and the FBI have signed a Memorandum of Understanding that acknowledges the role of the FBI in investigating criminal violations of Federal law, and the statutory mandate of the Inspector General to investigate and report on matters which involve the programs and operations of NASA. The memorandum provides that the FBI and NASA's Office of the Inspector General will cooperate on investigations of criminal activities which involve NASA programs and functions. The Office of the Inspector General will direct efforts at the detection and prevention of fraud, waste and inefficiency, and conduct, supervise and coordinate Inspector General audits and investigations relating to the programs and operations of NASA. The FBI will retain investigative jurisdiction in matters consisting of bribery, attempted bribery, or other corruption which culpably involve U.S. Government employees.

Four NASA employees received oral and written reprimands as a result of an investigation conducted by the Office of the Inspector General. The investigation was initiated following a lead provided by a NASA employee alleging violation of procurement practices. Results of the investigation revealed that NASA's sole-source procurement practice was being violated by several employees who had falsely certified documents with the intent of shortcutting the procurement process.

They've Got the Whole Shuttle in Their Hands

On June 27 NASA is scheduled to launch the Space Shuttle Columbia for the fourth time from launch pad 39A at Kennedy Space Center, Fla. Part of the enormous job of readying the orbiter for a new mission requires vertically lifting the vehicle once inside Kennedy's Vehicle Assembly Buliding (VAB) where it is mated with the External Tank and twin Solid Rocket Booster assembly.

Such a task rests with two employees of a 32-member Boeing Services International (BSI) crew which has the job of running cranes used to lift and transport Space Shuttle flight hardware around the Spaceport's facilities. For an inside look at what it is like to have America's manned space program literally in one's hands, we turn to BSI crew members Dave Earhart and Tom Shinholster.

Boeing Services International crane operators Tom Shinholster (left) and Dave Earhart man the controls of the 250-ton crane used to lift the Shuttle orbiter for mating with the solid rocket boosters and external tank.

As they explain, operating cranes are only a part of the crews' work but without doubt is the most challenging task they face. "You do, at some point or another, have every part of the flight hardware in your hands," says Earhart who was at the controls when Columbia was lifted above the VAB's transfer aisle and over into High Bay 3 prior to the first two Shuttle launches.

Earhart has been on this job for two years and describes his work as exciting, rewarding, exhausting and sometimes a little nervewracking. He quickly notes that when he looks out the window of the crane's cab and sees Columbia suspended 300 feet below (the length of a football field) he has a single overpowering thought—"To do the very best job I can."

Tom Shinholster is a Kennedy Space Center veteran. He joined the crew 15 years ago, after working on a construction crane during the building of Kennedy Space Center facilities.

He also was involved in hoisting the Shuttle orbiter during preparation for the first two missions. While most people would be thrilled to just get a glimpse of the Columbia, Shinholster says that handling something even as unique as America's new manned spacecraft becomes basically routine. He's quick to point out that those whose fingertips control the lifting of the 100-ton spaceship depend on other crew members. The guy on the ground paints the picture for you," he explained.

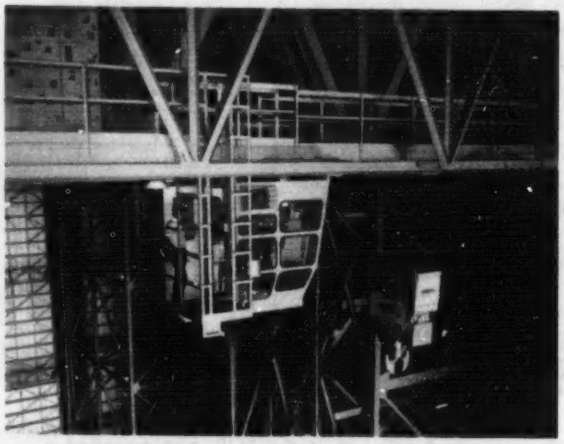
Sitting 468 feet above the VAB floor, Shinholster points out, is hardly an ideal vantage point for eyeballing the movement of the orbiter which must pass by some structures with a clearance of only a few inches. When the Columbia is lowered into position for mating with the solid rocket boosters and external tank, the alignment must be precise.

"There's no margin for error," says BSI supervisor Wayne Crawford, who handled the cranes back in the days when it was Saturn V segments and Apollo command modules being hoisted about the Vehicle Assembly Building. Crawford uses a crew of about a dozen technicians for the orbiter hoist operation.

Two persons operate the crane from the overhead cab and the rest take positions on the ground and selected levels to provide guidance to those with their hands on the control sticks.

Sitting in the left-hand seat of the cab, Shinholster demonstrates how he moves the crane and its loads forward, backward, and sideways. He grips a hand lever, which resembles the floor gear-shifter in a standard transmission car, and eases it to the left. A motor begins to whine and the VAB floor seemed to move westward. "What you do is start off real slow and just increase it," he explains. "You don't make any sudden stops."

In the right-hand seat, Earhart occupies the position of the crewman in charge of raising and lowering the load, and communicating with other members of the team. "The thing that amazes me about this equipment is that you can take a 250-ton load and move it in just about any direction as little as 1/128th of an inch," said Earhart.

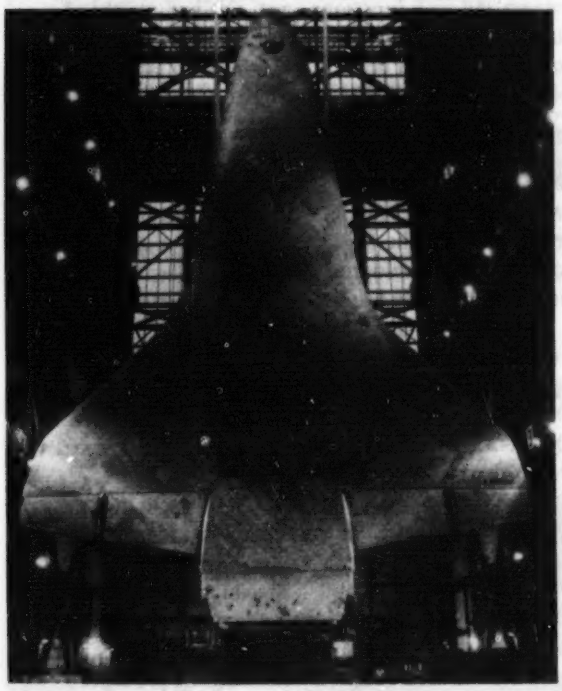


Crane used to hoist the Shuttle orbiter for mating with the external tank and solid rocket boosters is operated by Boeing Services International crews from a cab which sits 468 feet above the Vehicle Assembly Building floor.

He gently grasps the hand control and fixes his eyes on a small dial marked in increments of 1/64th of an inch. The needle slowly moves midway between two marks . . . and stops.

"It's like driving your car," says Crawford. "You have to know what you're doing."

In addition to lifting the Space Shuttle in the Vehicle Assembly Building, Crawford's BSI crew operates cranes in the Orbiter Processing Facility, at the pad, and at the Shuttle landing facility. They lift all other Shuttle hardware as well and are responsible for moving work platforms, and for opening the VAB doors when it is time for the Space Shuttle to roll out to the launch pad.



The pinnacle of their labor reached, Space Shuttle Columbia is suspended by the 250-ton crane in Kennedy's Vehicle Assembly Building manned by Boeing Services International operators Tom Shinholster and Dave Earhart. The three points where the orbiter attaches to the external tank are prominent in this view.

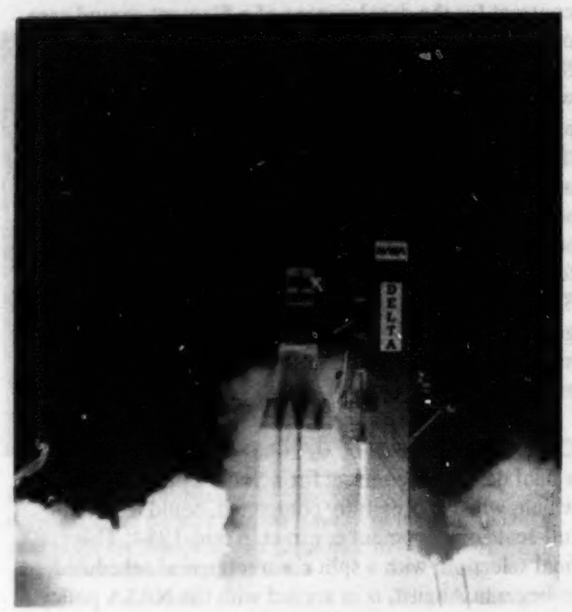
Contractor News

NASA's Marshall Space Flight Center, Huntsville, Ala., has selected **Hercules Inc.,** and **Votaw, Precision Tool, Inc.,** Magna, Utah, a joint venture, for negotiation under the Space Shuttle solid rocket booster contract for the development of a filament wound case configuration for the solid rocket motor used in the Space Shuttle's solid rocket boosters. The filament wound case subcontract will be a cost plus incentive/award fee type for design, development, test and delivery of four flight cases for a proposed cost of approximately $33 million. The filament wound case segments will replace portions of the current steel case segments for high performance launches. The performance increase is achieved by a reduction in the Shuttle liftoff weight of approximately 29,937 kilograms (66,000 pounds) from the baseline steel case motors. The first use of the wound case motors is expected late in 1985.

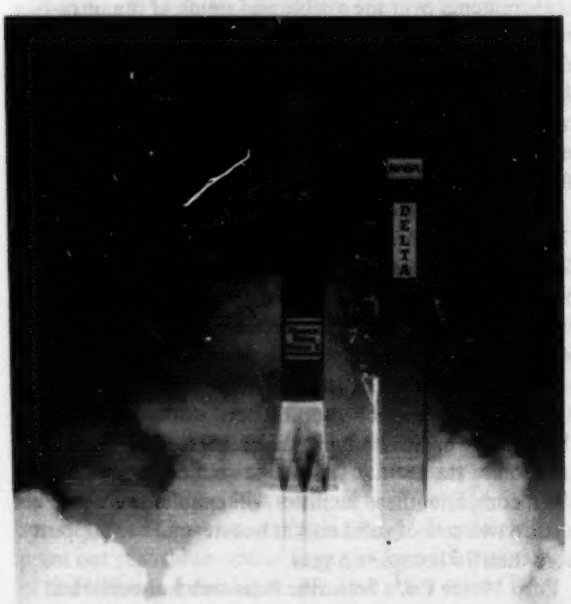
Perkin-Elmer Corp., Optical Group, Danbury, Conn. has been selected by NASA for negotiation of a final definition contract for a Solar Optical Telescope which, when successfully completed, could lead to a full-scale development contract in mid-1984. This final selection, with a split contract period scheduled to begin in August, is in accord with the NASA policy not to commit to full scale hardware development until all technical issues have been resolved and a final cost has been established which will provide a reasonable basis for completion of the work within the agreed upon schedule. The contractor's proposed cost for the entire effort including options is approximately $57 million. The Solar Optical Telescope will take measurements over the visible and much of the ultraviolet wavelength range of the Sun using a Gregorian telescope system with extremely fine resolution. The observatory is designed to provide a major step forward in the scientific study of solar physics by getting above the resolution limit imposed by Earth's atmosphere.

NASA's Kennedy Space Center has awarded a $7.2 million contract to **W&J Construction Co.,** Cocoa, Fla., to construct a complex of new buildings to process and store solid rocket booster segments. Under the terms of the fixed-price contract, W&J will provide the labor, equipment and materials to construct the Solid Rocket Booster Rotation/Processing Facility and two booster segment storage buildings. The award was made to a small business firm. Construction of the facilities is to take about 18 months. When complete, these facilities will enable Kennedy to store two sets of solid rocket boosters and to support more than 20 launches a year.

Ford Motor Co.'s Scientific Research Laboratories, Dearborn, Mich., has been awarded a $6.8-million contract by NASA's Lewis Research Center, Cleveland, to develop the technology for an advanced



Successful Deltas—Two recent successful launches of communications satellites using Delta expendable vehicles. Top photo is INSAT-1, an Indian communications satellite launched April 10 from the Eastern Space and Missile Center, Fla.; bottom photo is WESTAR-V, a Western Union communications satellite launched June 8 also from Eastern Space and Missile Center.



powertrain that could be used in future electric cars. Specific goal of the three-year contract is to establish and verify critical technologies associated with developing a lightweight, low-cost and highly efficient powertrain. An improved powertrain is a key to significantly enhancing the near-term possibility of an affordable electric vehicle. Under the contract, an experimental, proof-of-concept powertrain will be built. This powertrain, as conceived by Ford, would consist of a unique and innovative integral, concentric ac motor/automatic transaxle, an inverter/motor controller and a vehicle controller. The motor differential and a two-speed automatic shift transmission would be integrated into a single unit. By integrating such functions, cost, size and weight of the unit would be considerably lower than if each were to be separated. **Ford will subcontract** a large portion of the electrical subsystem work to **General Electric Co.'s Research and Development Center,** Schenectady, N.Y. G.E. will develop technology for the motor, inverter and motor controller and conduct laboratory tests on the complete powertrain. Ford will be responsible for the overall system technology, the research and development for the transaxle, fabrication of the vehicle test bed and the powertrain tests.

NASA's Johnson Space Center, Houston, has awarded a letter contract to **Rockwell International's Space Operations/Integration and Satellite Systems** Div., Downey, Calif., covering integration of the OSTA-3 (Office of Space and Terrestrial Applications) payload into Shuttle orbiter Columbia. Initial value of the letter contract is $370,000 and the total amount of the definitive cost-plus fixed fee contract is $3,772,000.

Rockwell will assemble a special pallet or an orbital flight pallet and integrate onto the pallet OSTA-3 scientific instruments and support subsystems. The contract will also cover payload staging, preflight checkout and postflight operations at NASA Kennedy Space Center. The OSTA-3 payload is currently scheduled to fly aboard Columbia on flight 16, June 1984.

International Business Machines Corp., Cape Canaveral, Fla., has been awarded a $1,558,420 contract modification by NASA's Kennedy Space Center for additional services under an existing contract. IBM is presently under a three-year contract extension with Kennedy for systems engineering and software development services in support of the Launch Processing System used at the Spaceport for automated checkout and launch of Space Shuttle vehicles. This award, for additional work under that existing contract, brings the total value of the contract to $85,913,954. The cost-plus-award-fee contract modification covers the period from Jan. 19, 1982 through Sept. 30, 1984.

NASA has selected **American Airlines' Flight Academy,** Ft. Worth, Texas, for contract negotiations for installation of a new helicopter simulator system caled Advanced Cab and Visual System at Ames Research Center, Mountain View, Calif. The system will be funded by the U.S. Army and will be used jointly by the Army and NASA. The system is designed to duplicate helicopter cockpit configurations and flight handling characteristics. The complex will provide a systems approach to rotorcraft design and a simulation capability to support handling quality experiments, flight tests, product improvement evaluations and basic rotorcraft technology. The proposal was for approximately $16 million. Pilots and engineers will use the new system to simulate the total handling characteristics of helicopter flight, including sight, motion and sound. The system can be run as a stationary installation or can use the Vertical Motion Simulator Facility to generate large motions.

Wackenhut Services, Coral Gables, Fla., has been awarded a $9.6 million supplemental contract by NASA's Kennedy Space Center for security and fire protection services. The cost-plus-fixed-fee contract supplement carries a dollar value of $9,628,389, bringing the total value of the Wackenhut contract at Kennedy to $48,980,083. The supplement covers the period from when the contract was awarded on April 1, 1982, through October 31, 1982.

Grit and Determination—These two elements clearly displayed on the face of astronaut Sally Ride as she underwent water survival training as an astronaut candidate. Part of what is termed a "drop and drag phase," students are dropped from the rear of a moving boat and then must release themselves from a parachute harness while being dragged on the stomach and back. Ride, the first woman astronaut to go into space, is scheduled for the seventh Space Shuttle mission in April 1983.

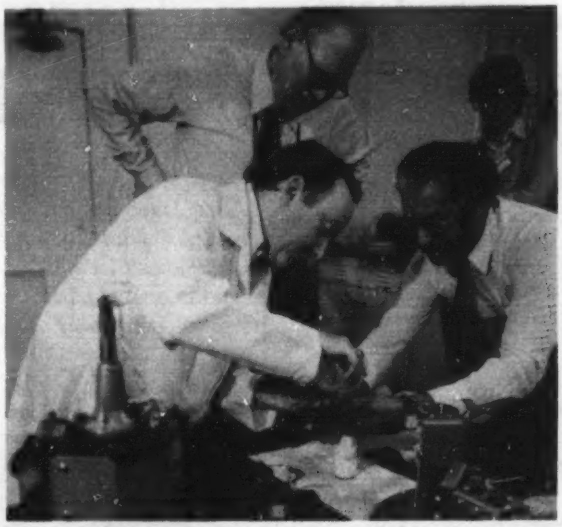
NASA's Marshall Space Flight Center, Huntsville, Ala., has awarded twin $1 million contracts to two optical companies to build precision mirrors representative of those to be flown on NASA's Advanced X-Ray Astrophysics Facility, or "AXAF," an orbiting X-ray observatory proposed for launch later in the decade. The double contract award assigns responsibility for parallel but independent work toward the building of these test mirrors, not intended to be flown in space to **ITEK Corp.,** Lexington, Mass., and to **Perkin-Elmer Corp.,** Danbury, Conn. Each of the contracts is two years in duration. At the end of the contract period, the two companies will be expected to present their individual approaches to the grinding and polishing of the actual mirror which will be built for the observatory in the late 1980s. The test mirrors will be smaller than the mirror to be flown in space. The test mirrors will allow NASA to evaluate the ability of these contractors to achieve the level of performance necessary. A greater precision than previously achieved in X-ray optical systems is sought. Proposed for launch in 1989 or 1990, the observatory would be technologically superior to any X-ray facility previously sent into space. Weighing 100,000 kilograms (11 tons) and measuring 4.2 by 13 meters (14 by 43 feet) it would be carried by the Space Shuttle and placed in an orbit 485 kilometers (300 miles) above the Earth for operation over a lifetime of about 15 years. The observatory is expected to view X-ray sources toward the very edge of the observable universe.

Did You Know?

Approximately 70,000 people called a special 900 number during the third flight of Columbia to monitor the air-to-ground commentary. NASA plans to offer this same service for the fourth Space Shuttle flight, scheduled for launch June 27. The phone exchange, (900) 410-6272, will operate 1-2 hours before launch through end of mission.

The Space Shuttle Columbia was the topic of a promotional campaign by Cherrios cereal and proved to be big business. For three box tops, kids could receive a Shuttle booklet and kit (consisting of a decal and an iron-on patch for t-shirts). For an additional dollar, they could receive a balsa/styrofoam model of the spacecraft. By April 1, the company had received over 350,000 responses (representing over a million boxes of cereal sold) for the booklet and kits; over half that figure had enclosed the money for a Shuttle model.

NASA Lewis aeronautics engineer **Peggy L. Evanich** has received the prestigious **Distinguished New Engineer Award** presented by the National Society of Women Engineers. Evanich is now participating in a one-year training period in a Headquarters career development program where she has been assigned to the Office of Aeronautics and Space Technology Transport Aircraft office working on programs that parallel her job at Lewis: studying the effects of icing on aircraft structures, propellers and engines. Evanich was cited for her outstanding and sustained efforts as project manager of aircraft icing research programs.



Early Results Look Good—NASA and university scientists who worked on the Marshall Space Flight Center-managed Monodisperse Latex Reactor experiment flown during the third flight of Columbia say they are "highly elated" by early results from the experiment. The latex reactor is designed to produce identical micron-sized beads in space that can be used for calibration of scientific and industrial equipment and also has potential major medical research applications. The experiment consists of four small metal cylinders, each containing a latex recipe, housed in square electronics packages encased in a metal drum. Early indications are that during the Shuttle mission, the latex beads were grown from their initial size of 2.5 microns to possibly twice that size. A key element in the experiment is to produce the particles in monodisperse, or identical size quantities. Dale Kornfield, of Marshall's Space Sciences Laboratory and co-investigator on the Monodisperse Latex Reactor experiment, pours the latex mixture produced in space during STS-3. He is assisted by co-investigator Mohamed S. El-Aasser (right) and Principal Investigator Dr. John W. Vanderhoff, (standing) both of Lehigh University.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Charlie M. Jackson, Jr., Samuel M. Dollyhigh and David S. Shaw, NASA/LaRC	Metric half-span model support system	4,327,581	LaRC
Thomas J. Pivirotto, Caltech/JPL	High power metallic halide laser	4,328,464	NRO/JPL
Alain L. Fymat, Caltech/JPL	Frequency-scanning particle size spectrometer	4,329,053	NRO/JPL
Richard P. Johnston Malcolm H. Knapp and Charles E. Coulson, General Electric, Cincinnati, Ohio	Active clearance control system for a turbomachine	4,329,114	LeRC
Bruce A. Banks, Albert J. Weigand and James S. Sovey, NASA/LeRC	Texturing polymer surfaces by transfer casting	4,329,385	LeRC
Wolf Elber, NASA/LaRC	Means for controlling aerodynamically induced twist	4,330,100	LaRC
Paul J. Shlichta, Caltech/JPL	Electromigration process for the purification of molten silicon during crystal growth	4,330,359	NRO/JPL
Jack W. Holt, Donald D. Helman and Laurence W. Smiser, Rockwell International Corp., Downey, Calif.	Method for repair of thin glass coatings	4,330,572	KSC
Joseph S. Heyman, NASA/LaRC	Acoustic tooth cleaner	4,331,422	LaRC
Robert Richter, Caltech/JPL	Solid electrolyte cell	4,331,742	NRO/JPL
Dean W. Sheibley, NASA/LeRC	Advanced inorganic separators for alkaline batteries	4,331,746	LeRC

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	March 22	KSC	OSS-1
Columbia (OV-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November	KSC	SBS-B

---

* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C'	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communication. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1A	April 8	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
Navy 21	October	Scout	WSMC	DOD transit. Reimbursable. Callup.
Landsat-D	July 9	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August 12	Delta	ESMC	Canada communications. Reimbursable.
Intelsat V-E	September	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-E	October	Delta	ESMC	RCA communications. Reimbursable.
San Marco-D/L	November	Scout	ESMC	International cooperative/Italy.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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* Successful launch

Another Dividend from Air and Space

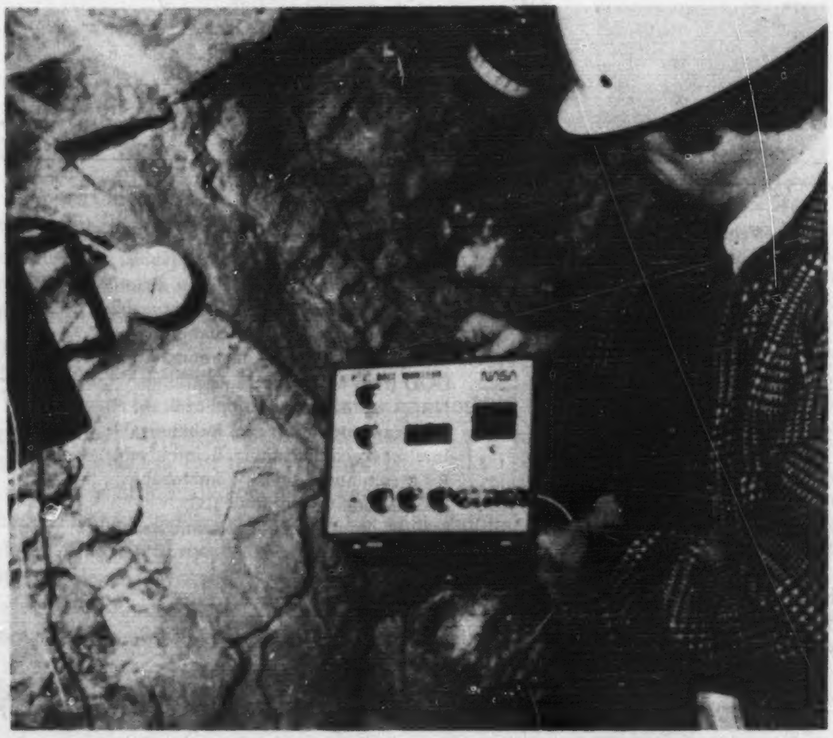
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Improved Mine Safety

A device developed by NASA's Langley Research Center to accurately measure bolt stress within wind tunnels could offer a way to improve the nation's mine safety.

Within wind tunnels, bolted segments must withstand high pressures. Langley's Pulse Phase Locked Loop monitor* is an ultrasound system that measures the stress that occurs when a bolt becomes elongated in the process of tightening. The instrument transmits sound waves to the bolt being fastened and receives a return signal indicating changes in bolt stress. It measures the effective changes in resonance due to elongation and changes in sound velocity due to strain. The results are translated into a digital reading of the real stress on the bolt.

Langley, in cooperation with the Department of the Interior's Bureau of Mines, has developed a version of the monitor to check bolt stress in the roofs of mine tunnels where mammoth bolts several feet long extend far into solid rock. Use of the instrument increases safety by assuring proper preloading of roof bolts. Langley and the Bureau of Mines plan to modify the monitor to measure stress of the rock surrounding the tunnel which would serve as a hazard warning. Rock stress varies from mine to mine and may change over time. If rock stress measurement proves feasible, it could provide broad benefit to such related activities as earthquake prediction. In photo the Langley-developed bolt monitor tests bolt stress at the Colorado School of Mines Experimental Mine Facility.



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For the benefit of all . .

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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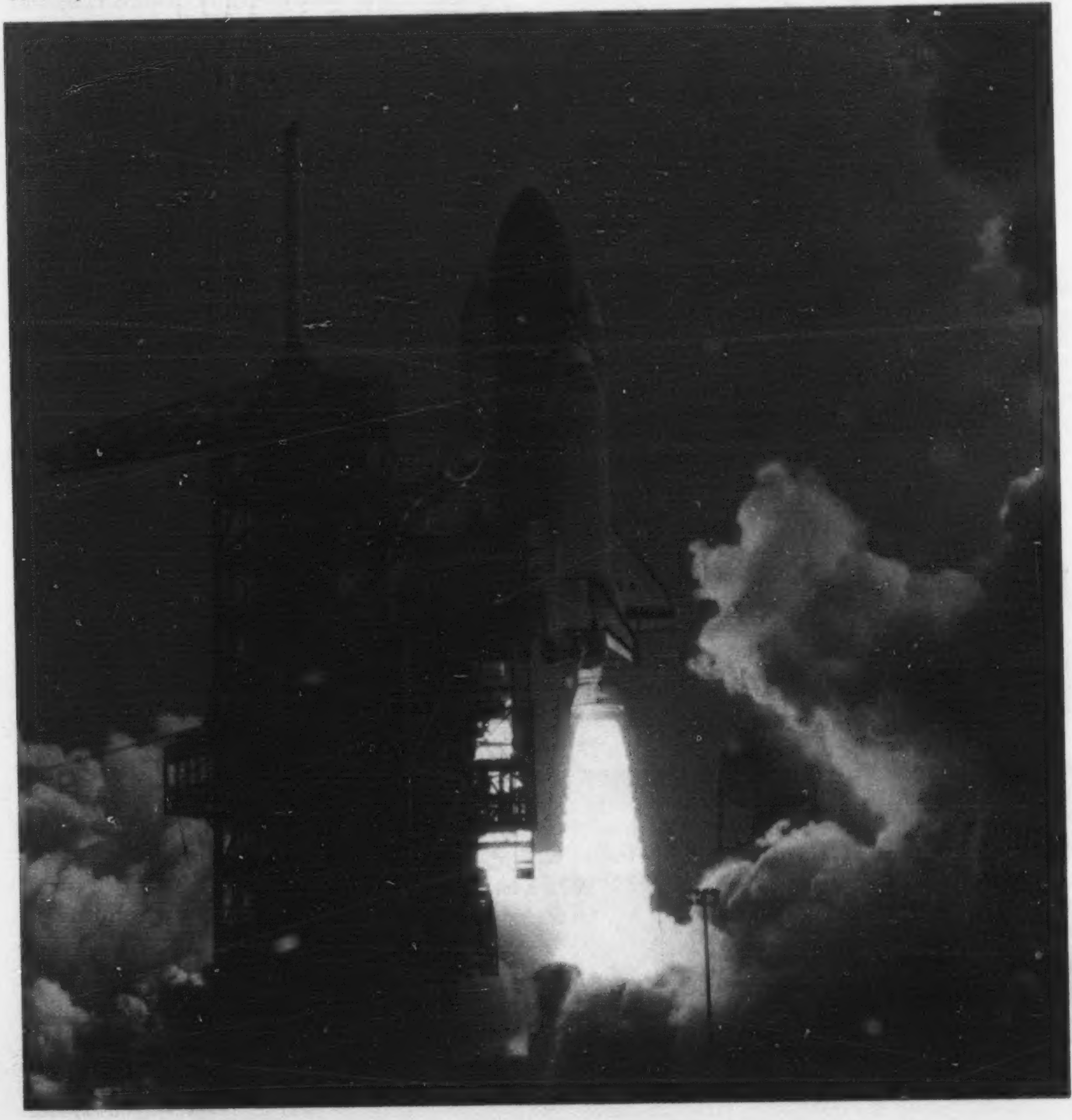

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About the Cover

Fourth launch of the Space Shuttle Columbia June 27 from NASA's Kennedy Space Center, Fla. Completing 7 days in space, Columbia travelled 3 million miles to land back on Earth on the nation's 206th birthday to complete the spacecraft's fourth and final test flight. The first operational Space Shuttle mission is scheduled for launch no earlier than November 11 and will carry a crew of four: Vance D. Brand, commander; Robert F. Overmyer, pilot; Joseph P. Allen and William B. Lenoir, mission specialists. Below are scenes from the Mission Operations Control Room at Johnson Space Center, Houston. Top frame shows the control center monitoring the Shuttle during flight day two of the mission (screen at back left); bottom frame was taken the day of landing. Entry flight director Harold Draughan (foreground) views the flawless landing (second screen from back right).

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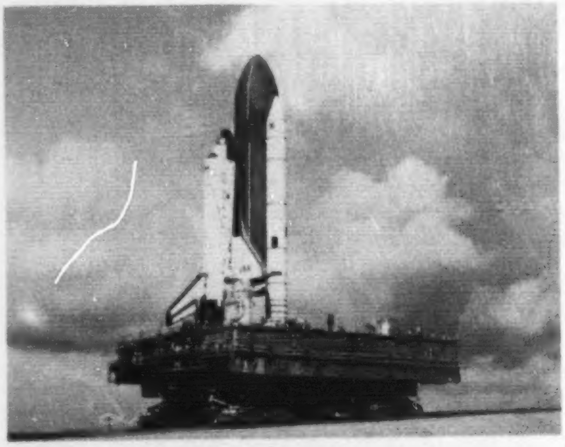
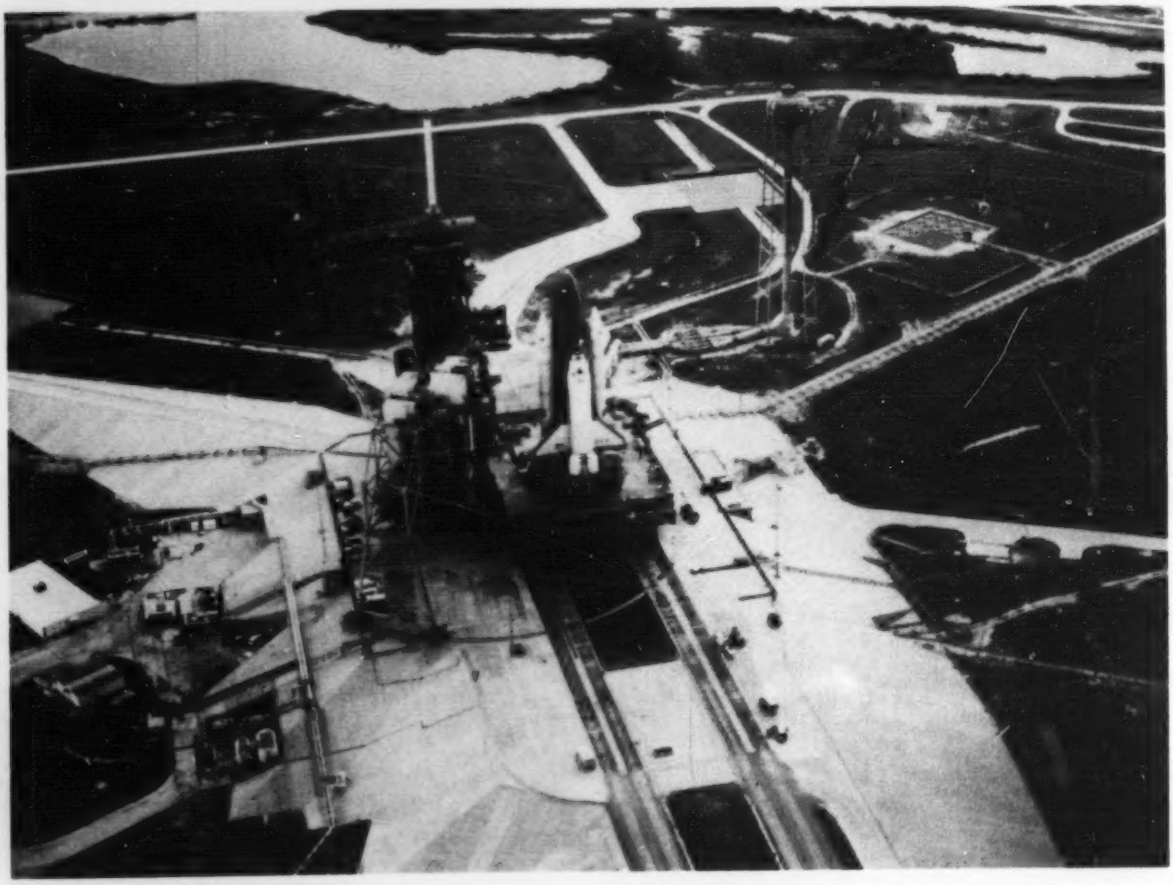
Space Shuttle Mission 4—Pictorial Highlights

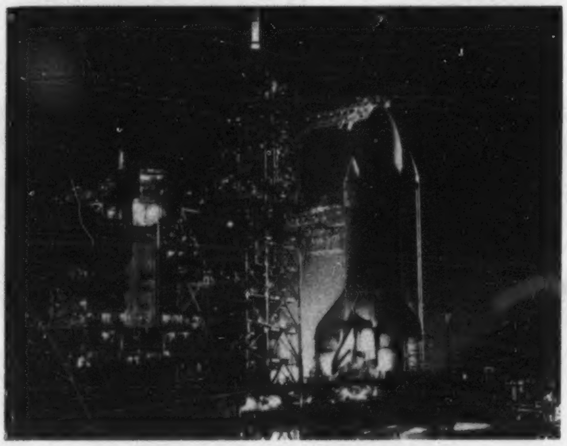
Crew	Thomas K. Mattingly, commander Henry W. Hartsfield, pilot
Rollover to Vehicle Assembly Building	May 19
Time in Orbiter Processing Facility	40 working days (shortest time to date)
Rollout	May 26
Launch	June 27
Launch time	11 a.m. EDT
Launch site	Kennedy Space Center, Fla. Pad 39A
Landing	July 4
Landing time	12:09:40 EDT
Mission duration	7 days, 1 hour, 11 minutes, 11 seconds
Orbits	112 full orbits, deorbit burn for reentry on 113th orbit

Fourth rollout of the Space Shuttle Columbia to Kennedy Space Center's launch pad 39A. The spacecraft's 3.5 mile journey from the Vehicle Assembly Building to the pad took approximately six hours to complete aboard the giant crawler transporter.





MATTINGLY – HARTSFIELD



Shuttle 4 commander T. K. Mattingly (right) and pilot Henry Hartsfield at Kennedy Space Center's Shuttle Landing Facility after flying simulated landing approaches in the NASA gulfstream jets. These aircraft are modified to produce flight characteristics similar to the Space Shuttle. **(top left)**

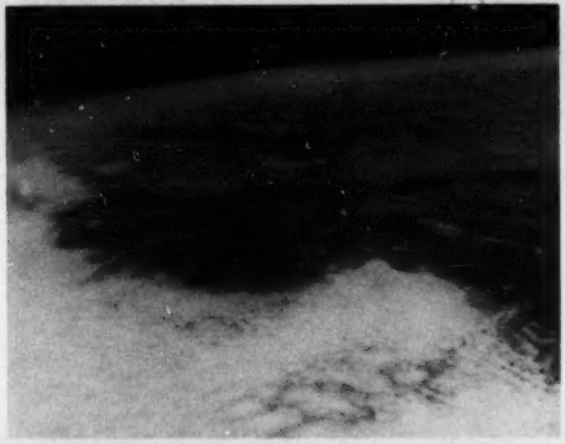
Fourth Shuttle prime crew at their pre-launch breakfast. Nancy Gunter, manager of the Kennedy Space Center astronaut office, provided the cake decorated with the colors and design of the mission patch. **(center left)**

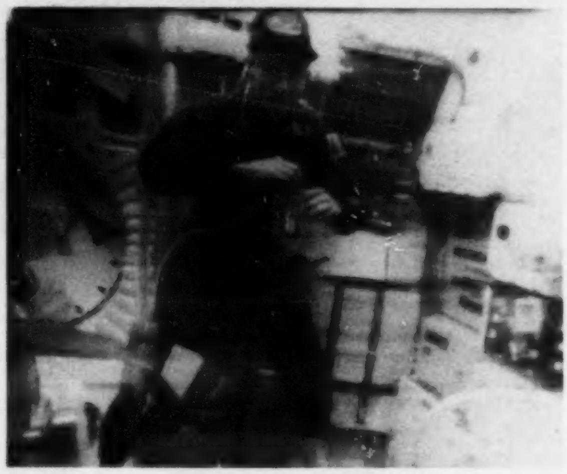
Mattingly and Hartsfield suit up for their 7-day mission the morning of June 27. **(bottom left)**

Shuttle mission 4 astronauts enter the launch pad "white room" where they complete flight preparations and enter the cockpit of Columbia. **(top right)**

Skyward streaming light silhouettes Columbia in the early morning hours on launch day, June 27. **(bottom right)**

Fourth launch of Space Shuttle Columbia, June 27. Liftoff time was 11 a.m. EDT. **(page 5)**





Photography from Columbia:

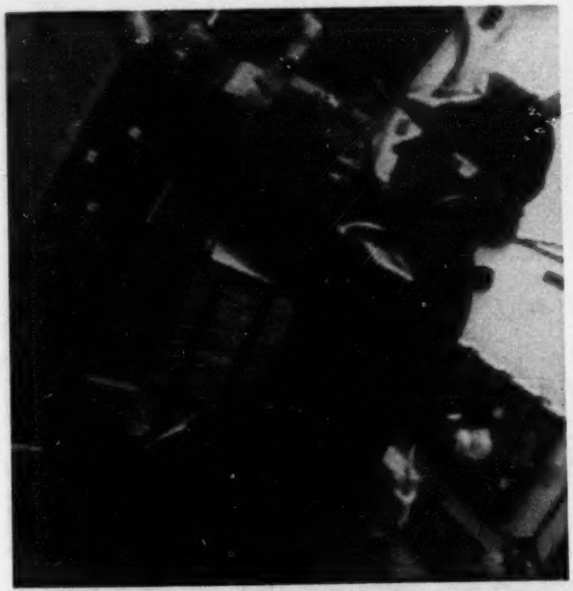
Baja California, Norte and Sonora states with sunlight on the Sea of Cortez (Gulf of California). Above and to the right of center are islands of Angel de la Guardia and Tiberon. **(top left)**

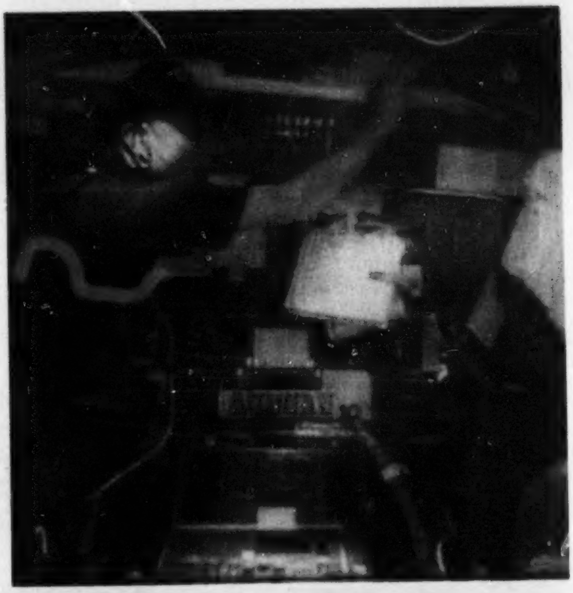
Northeastern view of California's Pacific Coast taken by a handheld 70-mm camera aimed through Columbia's windows. **(center left)**

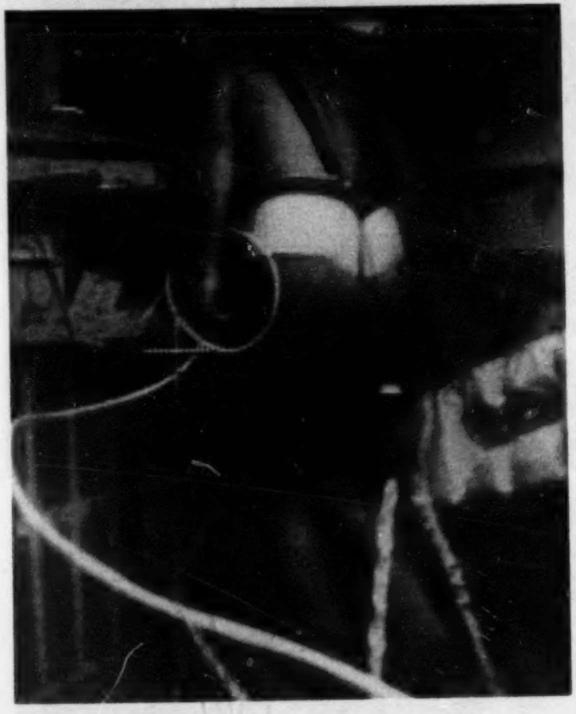
Silhouetted against the black of space, Columbia's Remote Manipulator System deploys the Induced Environment Contamination Monitor, a device to check for contaminants in and around the orbiter cargo bay. **(bottom left)**

Handheld camera scene of both Florida coasts. Cape Canaveral is located at center of the frame. This photo was taken through an aft window on the flight deck of Columbia. The spacecraft's vertical tail and orbital maneuvering system pods are in foreground **(top right)**

Space Shuttle TV: Flight day 4. Mattingly in the mid-deck section of the orbiter about to toss a plastic food container he is holding to illustrate a point about force in micro-gravity. **(bottom right)**





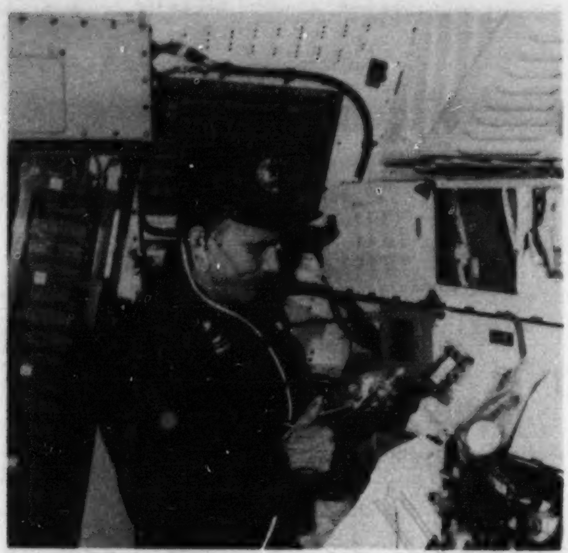


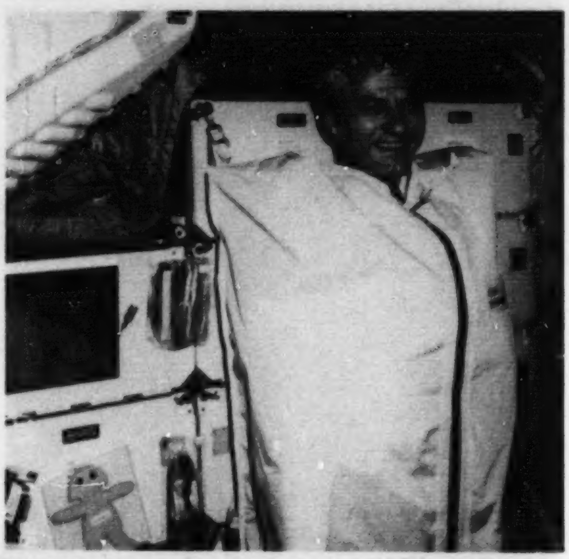
More Shuttle TV: Pilot Henry Hartsfield on flight day 4 gives an "open house" tour of the orbiter. He has wedged his socked feet beneath the Continuous Flow Electrophoresis System experiment located in the spacecraft's mid-deck. **(top left)**

On flight day 5, Hartsfield using the treadmill exercise device also located in Columbia's mid-deck. **(bottom left)**

T.K. continues the tour of the spacecraft on flight day 5, this view from the cockpit. A bumper sticker from the crew's alma mater, Auburn, is at lower center. **(top right)**

Flight Day 6, commander Mattingly undergoes suiting up exercise in the mid-deck area of Columbia. Suit worn by Mattingly is the EMU (extravehicular mobility unit), to be used on the next flight for EVA chores. **(bottom left)**





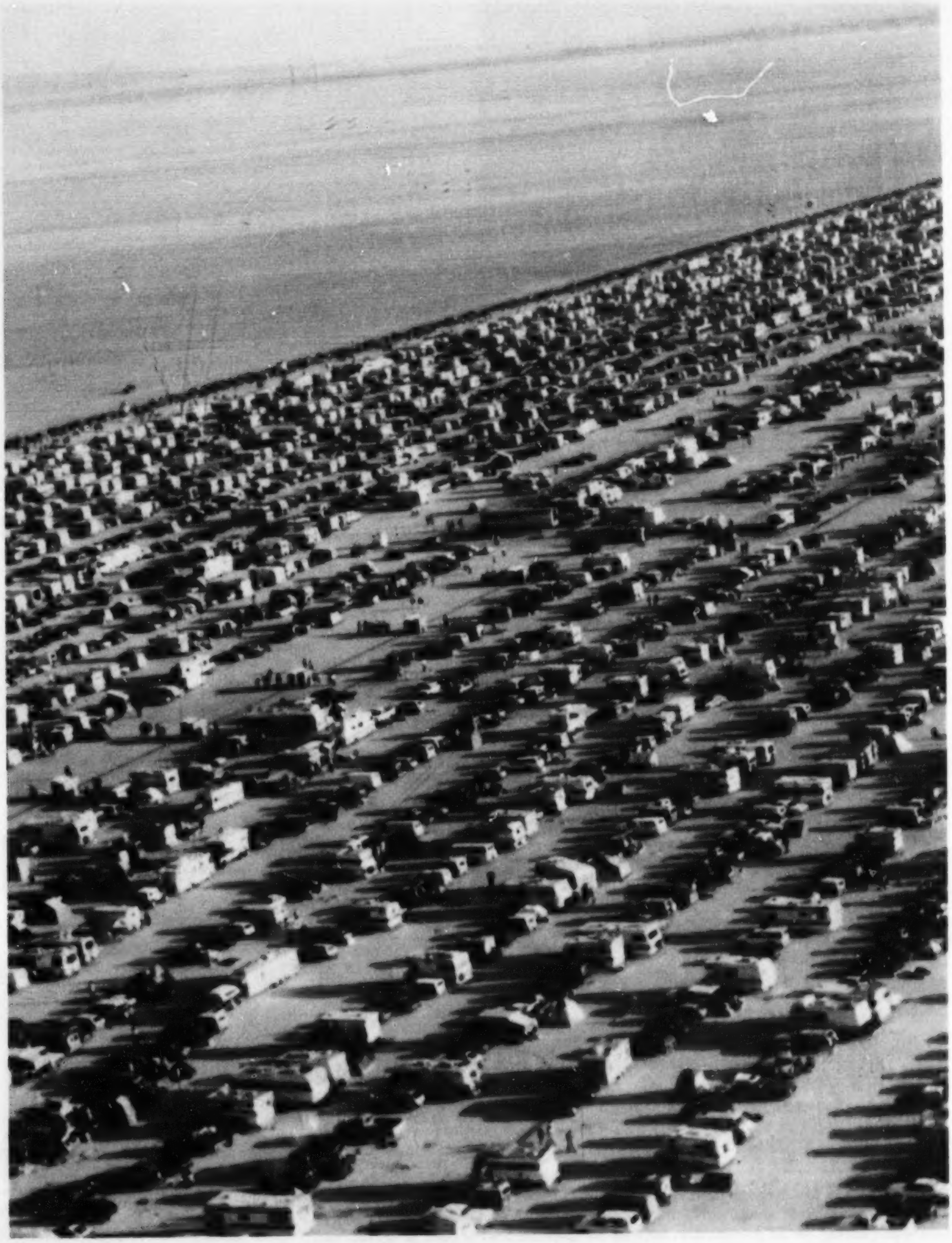
Commander Mattingly demonstrates meal preparation, using scissors to open a drink container. Various packages of food and meal accessories are attached to the locker door. **(top left)**

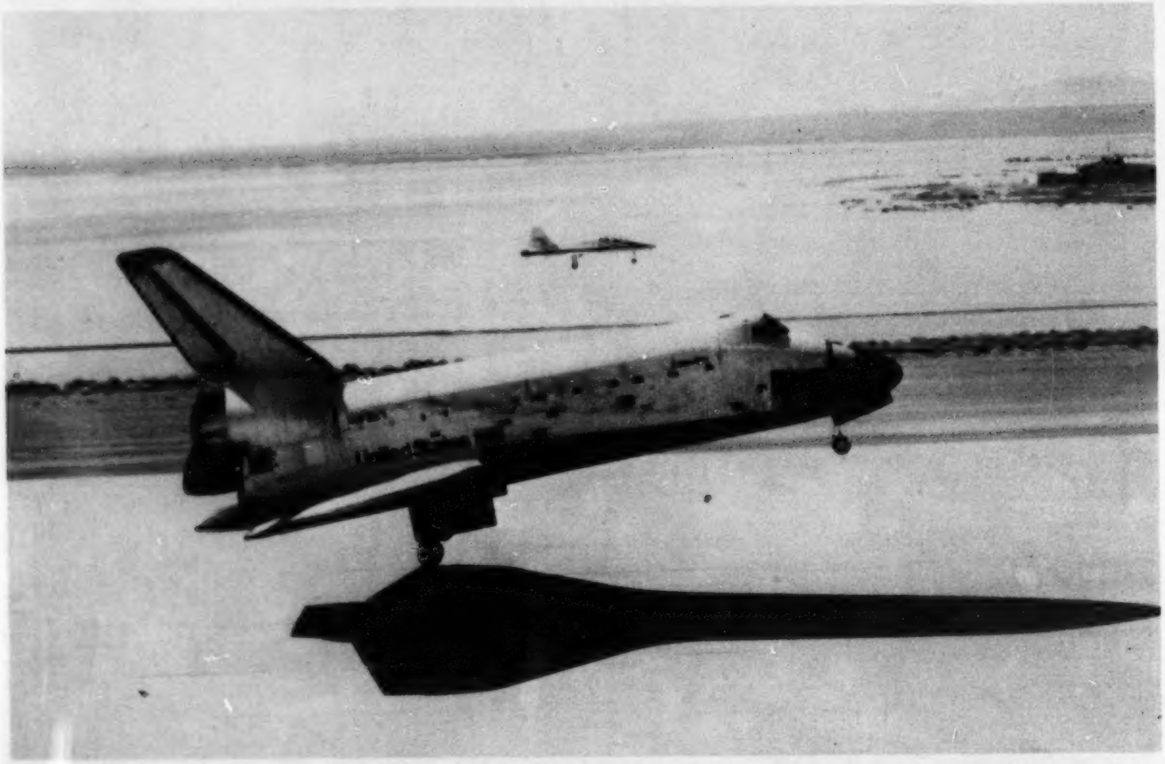
Hartsfield demonstrates the sleeping accommodations aboard Columbia. The sleep restraint is located in the mid-deck section of the orbiter. **(top right)**

Wide angle view of Johnson Space Center's Mission Operations Control Room during the final minutes of the launch countdown June 27. **(center)**

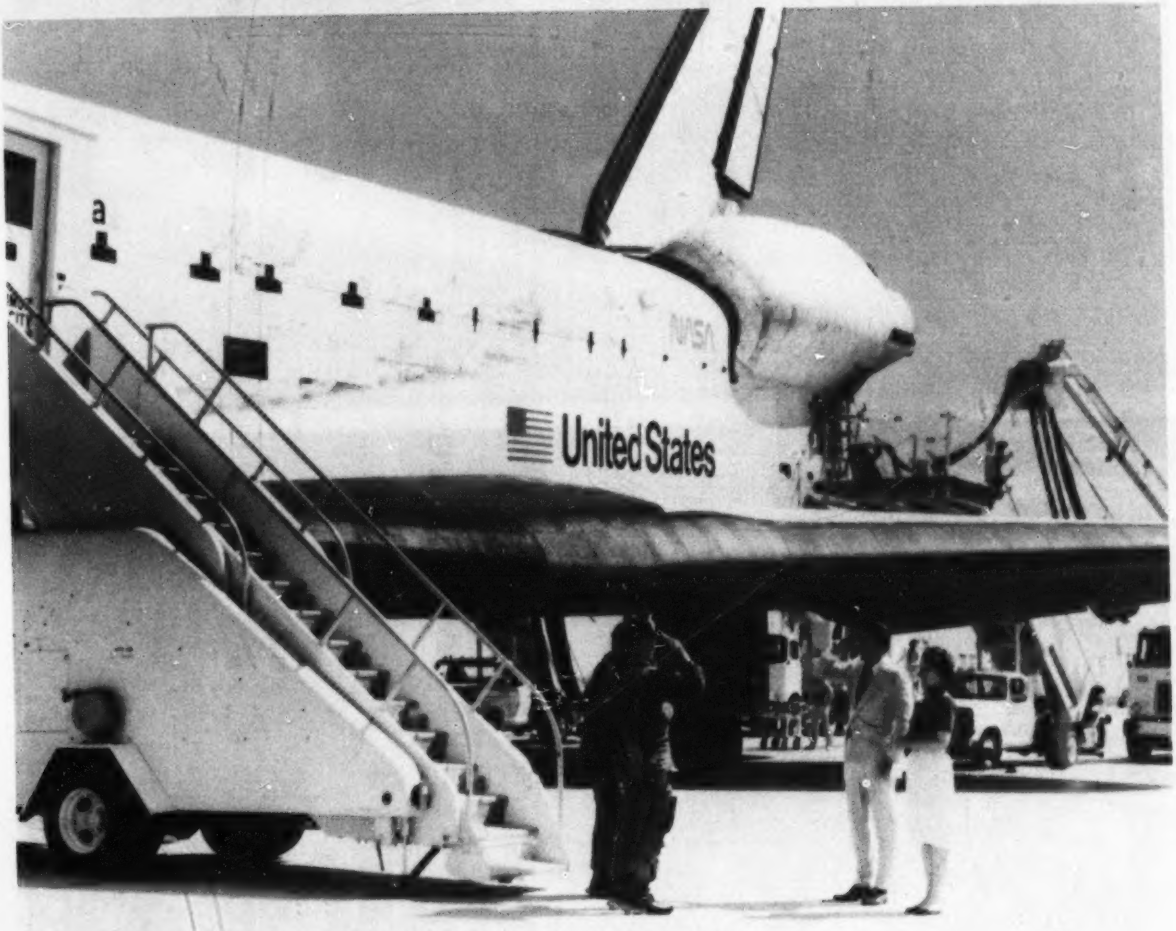
Fourth Shuttle mission lead flight director Chuck Lewis is congratulated following the successful landing of Columbia on July 4. **(bottom left)**

Cars and people as far as the eye can see on hand to witness the fourth landing of Columbia on July 4 at Edwards Air Force Base, Calif. The crowd numbered an estimated half a million people. **(pg. 9)**





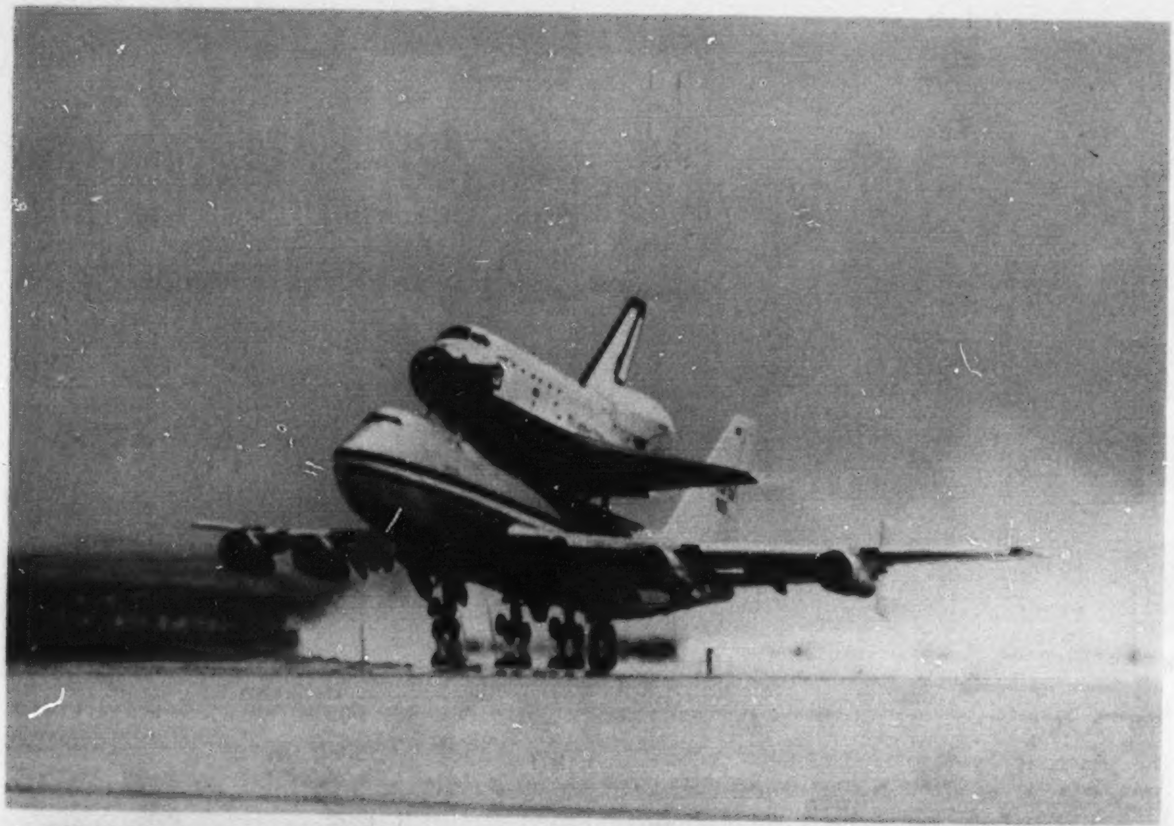
Columbia makes its final approach for landing at Edwards Air Force Base, Calif., on July 4 accompanied by T-38 chase planes (one is located at top right of orbiter). Back wheels seconds from touchdown **(bottom photo)** on concrete runway 17 at Edwards—Columbia's first landing on a hard surface runway; for the previous three missions, the spacecraft touched down on dry lakebeds.



Mattingly and Hartsfield are all smiles when they exit columbia after a flawless touchdown on July 4. **(top left)**

Fourth Shuttle mission prime crew are greeted by very special guests at touchdown: the President and Mrs. Reagan. **(top right)**

Mission 4 prime crew and the nation's commander-in-chief exchange salutes; the President and the astronauts spoke before a crowd of thousands at a special July 4 ceremony highlighted by the landing of Columbia and the takeoff of the newest orbiter Challenger aboard NASA Shuttle Carrier Aircraft bound for Kennedy Space Center, Fla. **(bottom)**



NASA
Enterprise
United States

Special landing day ceremony was the order at Edwards upon the historic touchdown of Columbia on the nation's 206th Independence Day. Three orbiters provided visual testimony of the progress and success of the U.S. space program: the orbiter Enterprise, used for approach and landing tests; Columbia; and NASA's newest orbiter, Challenger, given a signal by President Reagan during the ceremony to lift off aboard the Shuttle Carrier Aircraft for Kennedy Space Center **(page 12, top)** where it will undergo processing prior to its first launch in January 1983. On the speakers platform **(bottom, page 12)** flanked by the Enterprise, are left to right: pilot Hartsfield, President Reagan, commander Mattingly, NASA Administrator James M. Beggs (at podium) and Nancy Reagan. Perfect dead center landing for Columbia on concrete runway 17 at Edwards Air Force Base, Calif., **(top photo)** on July 4, proved the spacecraft's ability to make a precision landing.

Remarks by the President

Fourth Landing of the Space Shuttle Columbia

Dryden Flight Research Facility
Edwards Air Force Base, Calif.
July 4, 1982

In the early days of our republic, Americans watched Yankee clippers glide across the many oceans of the world, manned by proud and energetic individuals, breaking records for time and distance, showing our flag and opening up new vistas of commerce and communications.

Well, today you've helped recreate the anticipation and excitement felt in home ports as the gallant ships were spotted on the horizon, heading in after a long voyage.

Today we celebrate the 206th anniversary of our independence. Throughout history we've never shrunk before a challenge. The quest for new frontiers for the betterment of our homes and families is a crucial part of our national character—something which you so ably represent today. The space program, in general, and the Shuttle program, in particular, have gone a long way to help our country recapture its spirit of vitality and confidence. The pioneer spirit still flourishes in America.

In the future, as in the past, our freedom, independence and national well-being will be tied to new acheivements, new discoveries and pushing back frontiers. The fourth landing of the Columbia is the historical equivalent to the driving of the golden spike which completed the first transcontinental railroad. It marks our entrance into a new era. The test flights are over, the groundwork has been laid, now we will move forward to capitalize on the tremendous potential offered by the ultimate frontier of space.

Beginning with the next flight, the Columbia and her sister ships will be fully operational and ready to provide economical and routine access to space for scientific exploration, commercial ventures and for tasks related to the national security. Simultaneously, we must look aggressively to the future by demonstrating the potential of the Shuttle and establishing a more permanent presence in space.

We've only peered over the edge of our accomplishments; yet already the space program has improved the lives of every American. The aerospace industry provides meaningful employment to over a million of our citizens—many working directly on the space program, others using the knowledge developed in space programs to keep us the world leader in aviation.

In fact, technological innovations traced directly to the space program boost our standard of living and provide employment for our people in such diverse fields as communications, computers, health care, energy efficiency, consumer products and environmental protection. It's been estimated, for example, that information from satellites saves hundreds of millions of dollars per year in agriculture, shipping and fishing.

The Space Shuttle will open up even more impressive possibilities, permitting us to use the near weightlessness and near-perfect vacuum of space to produce special alloys, metals, glasses, crystals and biological materials impossible to manufacture on Earth.

Similarly, in the area of national security our space systems have opened unique opportunities for peace by providing advanced methods of verifying strategic arms control agreements.

The Shuttle we just saw land carried two kinds of payloads: one funded entirely by private industry and the other, related to our national security, sponsored by the Air Force. This versatility of the Columbia and her sister ships will serve the American people well. Yet we must never forget that the benefits we receive are due to our country's commitment, made a decade ago, to remain the world leader in space technology.

To insure that the American people keep reaping the benefits of space and to provide general direction for our future efforts, I recently approved a National Space Policy Statement—which is being released today.

Our goals for space are ambitious, yet achievable. They include:

- Continued space activity for economic and scientific benefits.
- Expanding private sector investment and involvement in space-related activities.
- Promoting international uses of space.
- Cooperating with other nations to maintain the freedom of space for all activities that enhance the security and welfare of mankind.
- Strengthening our own security by exploring new methods of using space as a means of maintaining the peace.

There are those who thought the closing of the western frontier marked an end to America's greatest period of vitality.

Yet, we are crossing new frontiers every day, the high technology now being developed, much of it a by-product of the space effort, offers us and future generations of Americans opportunities never dreamed of a few years ago. Today we celebrate American Independence confident that the limits of our freedom and prosperity have again been expanded by meeting the challenge of the frontier.

We also honor two pathfinders. They reaffirm to all of us that as long as there are frontiers to be explored and conquered, Americans will lead the way. They and the other astronauts have shown the world that Americans still have the know-how and Americans still have the true grit that tamed a savage wilderness.

Charles Lindbergh once said that "short-term survival may depend on the knowledge of nuclear physicists and the performance of supersonic aircraft, but long-term survival depends alone on the character of man."

National Space Policy

The White House
Office of the White House Press Secretary

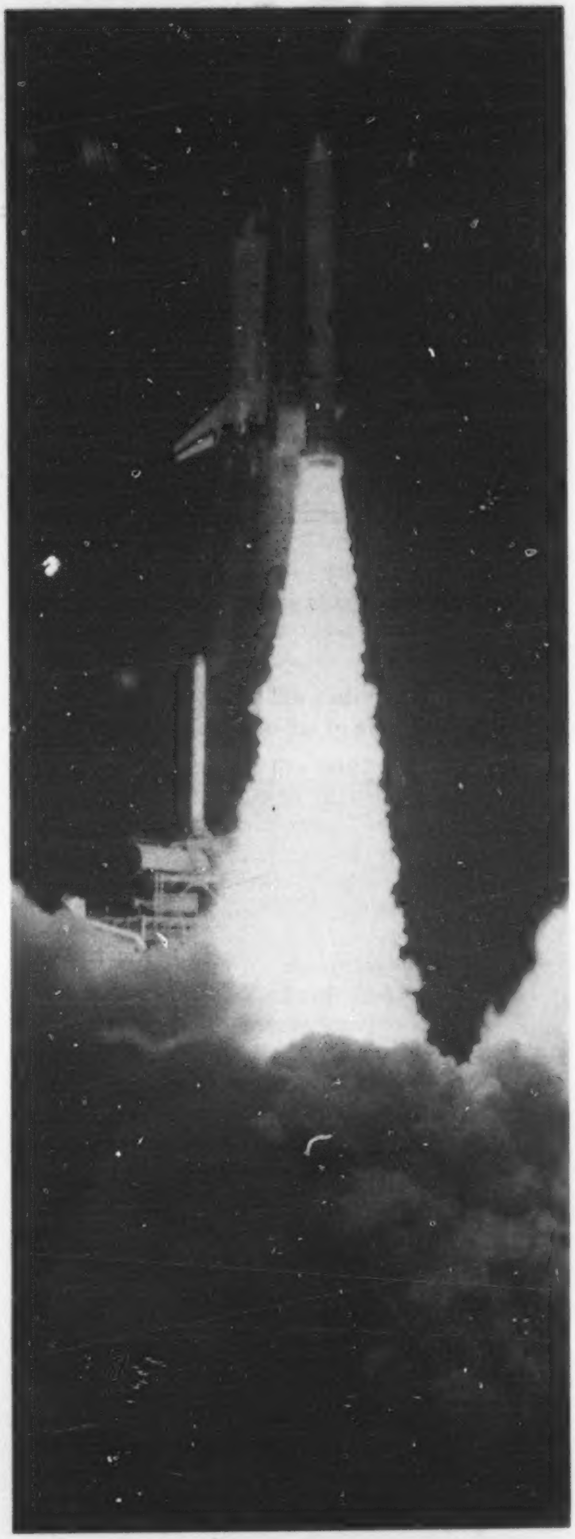
The President announced today [July 4, 1982] a national space policy that will set the direction of U.S. efforts in space for the next decade. The policy is the result of an interagency review requested by the President in August 1981. The ten-month review included a comprehensive analysis of all segments of the national space program. The primary objective of the review was to provide a workable policy framework for an aggressive, farsighted space program that is consistent with the Administration's national goals.

As a result, the President's Directive reaffirms the national commitment to the exploration and use of space in support of our national well-being, and establishes the basic goals of United States space policy which are to:

- strengthen the security of the United States;
- maintain United States space leadership;
- obtain economic and scientific benefits through the exploitation of space;
- expand United States private sector investment and involvement in civil space and space related activities;
- promote international cooperative activities in the national interest, and
- cooperate with other nations in maintaining the freedom of space for activities which enhance the security and welfare of mankind.

The principles underlying the conduct of the United States space program, as outlined in the Directive are:

- The United States is committed to the exploration and use of space by all nations for peaceful purposes and for the benefit of mankind. "Peaceful purposes" allow activities in pursuit of national security goals.
- The United States rejects any claims to sovereignty by any nation over space or over celestial bodies, or any portion thereof, and rejects any limitations on the fundamental right to acquire data from space.
- The United States considers the space systems of any nation to be national property with the right of passage through and operation in space without interference. Purposeful interference with space systems shall be viewed as an infringement upon sovereign rights.



- The United States encourages domestic commercial exploitation of space capabilities, technology, and systems for national economic benefit. These activities must be consistent with national security concerns, treaties and international agreements.

- The United States will conduct international cooperative space-related activities that achieve scientific, political, economic, or national security benefits for the nation.

- The United States space program will be comprised of two separate, distinct and strongly interacting programs—national security and civil. Close coordination, cooperation and information exchange will be maintained among these programs to avoid unnecessary duplication.

- The United States Space Transportation System (STS) is the primary space launch system for both national security and civil government missions. STS capabilities and capacities shall be developed to meet appropriate national needs and shall be available to authorized users—domestic and foreign, commercial and governmental.

- The United States will pursue activities in space in support of its right of self-defense.

- The United States will continue to study space arms control options. The United States will consider verifiable and equitable arms control measures that would ban or otherwise limit testing and deployment of specific weapons systems, should those measures be compatible with United States national security.

Space Transportation System

The Directive states that the Space Shuttle is to be a major factor in the future evolution of United States space programs, and that it will foster further cooperative roles between the national security and civil programs to insure efficient and effective use of national resources. The Space Transportation System (STS) is composed of the Space Shuttle, associated upper stages, and related facilities. The Directive establishes the following policies governing the development and operation of the Space Transportation System:

- The STS is a vital element of the United States space program, and is the primary space launch system for both United States national security and civil government missions. The STS will be afforded the degree of survivability and security protection required for a critical national space resource. The first priority of the STS program is to make the system fully operational and cost-effective in providing routine access to space.

- The United States is fully committed to maintaining world leadership in space transportation with a STS capacity sufficient to meet appropriate national needs. The STS program requires sustained commitments by each affected department or agency. The United States will continue to develop the STS through the National Aeronautics and Space Administration (NASA) in cooperation with the Department of Defense (DOD). Enhancement of STS operational capability, upper stages and methods of deploying and retrieving payloads should be pursued, as national requirements are defined.

- United States Government spacecraft should be designed to take advantage of the unique capabilities of the STS. The completion of transition to the Shuttle should occur as expeditiously as practical.

- NASA will assure the Shuttle's utility to the civil users. In coordination with NASA, the DOD will assure the Shuttle's utility to national defense and integrate national security missions into the Shuttle system. Launch priority will be provided for national security missions.

- Expendable launch vehicle operations shall be continued by the United States Government until the capabilities of the STS are sufficient to meet its needs and obligations. Unique national security considerations may dictate developing special purpose launch capabilities.

- For the near term, the STS will continue to be managed and operated in an institutional arrangement consistent with the current NASA/DOD Memoranda of Understanding. Responsibility will remain in NASA for operational control of the STS for civil missions and in the DOD for operational control of the STS for national security missions. Mission management is the responsibility of the mission agency. As the STS operations mature, the flexibility to transition to a different institutional structure will be maintained.

- Major changes to STS program capabilities will require Presidential approval.

The Civil Space Program

In accordance with the provisions of the National Aeronautics and Space Act, the Directive states that the civil space program shall be conducted:

- to expand knowledge of the Earth, its environment, the solar system and the universe;
- to develop and promote selected civil applications of space technology;
- to preserve the United States leadership in critical aspects of space science, applications and technology; and

- to further United States domestic and foreign policy objectives.

The Directive states the following policies which shall govern the conduct of the civil space program:

- United States Government programs shall continue a balanced strategy of research, development, operations, and exploration for science, applications and technology. The key objectives of these programs are to: (1) preserve the United States preeminence in critical space activities to enable continued exploitation and exploration of space; (2) conduct research and experimentation to expand understanding of: (a) astrophysical phenomena and the origin and evolution of the universe through long-lived astrophysical observation; (b) the Earth, its environment, its dynamic relation with the sun; (c) the origin and evolution of the solar system through solar, planetary, and lunar sciences and exploration; and (d) the space environment and technology to advance knowledge in the biological sciences; (3) continue to explore the requirements, operational concepts, and technology associated with permanent space facilities; (4) conduct appropriate research and experimentation in advanced technology and systems to provide a basis for future civil applications.

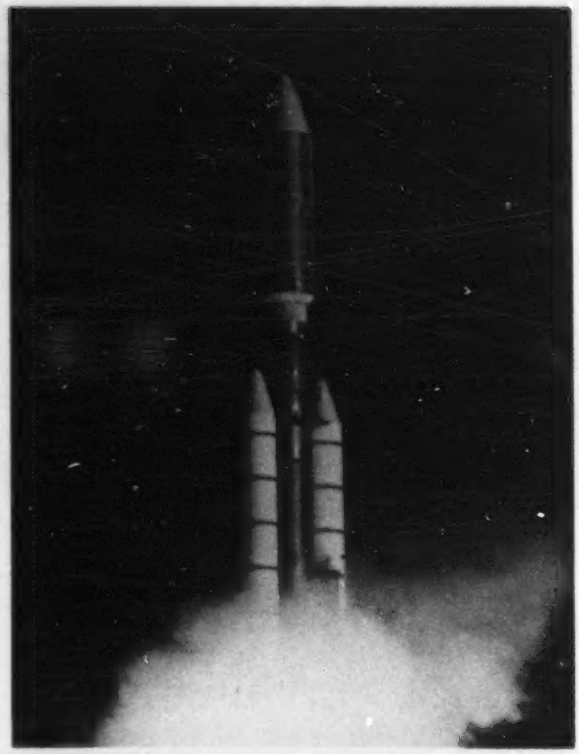
- The United States Government will provide a climate conducive to expanded private sector investment and involvement in space activities, with due regard to public safety and national security. These space activities will be authorized and supervised or regulated by the government to the extent required by treaty and national security.

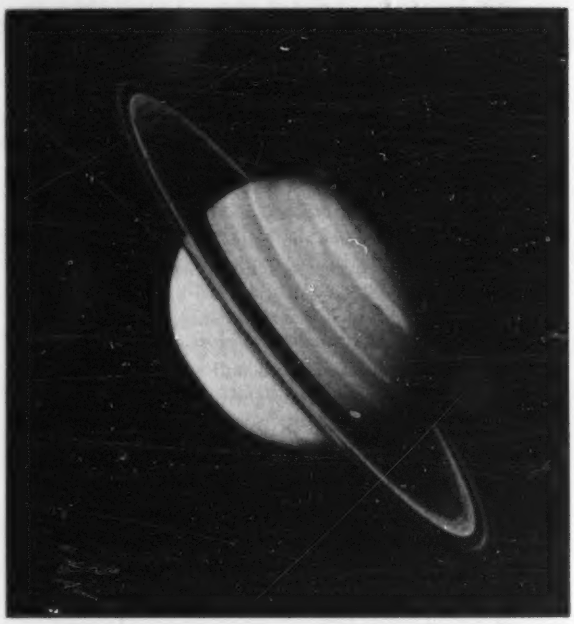
- The United States will continue cooperation with other nations in international space activities by conducting joint scientific and research programs, consistent with technology transfer policy, that yield sufficient benefits to the United States, and will support the public, nondiscriminatory direct readout of data from Federal civil systems to foreign ground stations and the provision of data to foreign users under specified conditions.

- The Department of Commerce, as manager of Federal operational space remote sensing systems, will: (1) aggregate Federal needs for these systems to be met by either the private sector or the Federal government; (2) identify needed research and development objectives for these systems; and (3) in coordination with other departments or agencies, provide regulation of private sector operation of these systems.

The National Security Space Program

The Directive states that the United States will conduct those activities in space that it deems necessary





Launch of the Voyager 2 spacecraft aboard a Titan/Centaur expendable vehicle on Sept. 5. 1977. Bottom photo shows one of the spacecraft's photos of Saturn. taken from a range of 27 million miles on July 12. 1981. one month. 11 days before the spacecraft's closest approach to the giant ringed planet.

to its national security. National security space programs shall support such functions as command and control, communications, navigation, environmental monitoring, warning, surveillance and space defense. The Directive states the following policies which shall govern the conduct of the national security program:

- Survivability and endurance of space systems, including all system elements, will be pursued commensurate with the planned use in crisis and conflict, with the threat, and with the availability of other assets to perform the mission. Deficiencies will be identified and eliminated, and an aggressive, long-term program will be undertaken to provide more assured survivability and endurance.
- The United States will proceed with development of an anti-satellite (ASAT) capability, with operational deployment as a goal. The primary purposes of a United States ASAT capability are to deter threats to space systems of the United States and its Allies and, within such limits imposed by international law, to deny any adversary the use of space-based systems that provide support to hostile military forces.
- The United States will develop and maintain an integrated attack warning, notification, verification, and contingency reaction capability which can effectively detect and react to threats to United States space systems.
- Security, including dissemination of data, shall be conducted in accordance with Executive Orders and applicable directives for protection of national security information and commensurate with both the missions performed and the security measures necessary to protect related space activities.

Inter-program Responsibilities

The Directive contains the following guidance applicable to and binding upon the United States national security and civil space programs:

- The national security and civil space programs will be closely coordinated and will emphasize technology sharing within necessary security constraints. Technology transfer issues will be resolved within the framework of directives, executive orders, and laws.
- Civil Earth-imaging from space will be permitted under controls when the requirements are justified and assessed in relation to civil benefits, national security, and foreign policy. These controls will be periodically reviewed to determine if the constraints should be revised.
- The United States Government will maintain and coordinate separate national security and civil operational space systems when differing needs of the programs dictate.

Administrator's Column

(Each month in this column *NASA Activities* will feature an article by NASA Administrator James M. Beggs. These articles will focus on subjects chosen by him to address topics of broad interest to the agency's employees.)

1990: Year of the American Space Station?

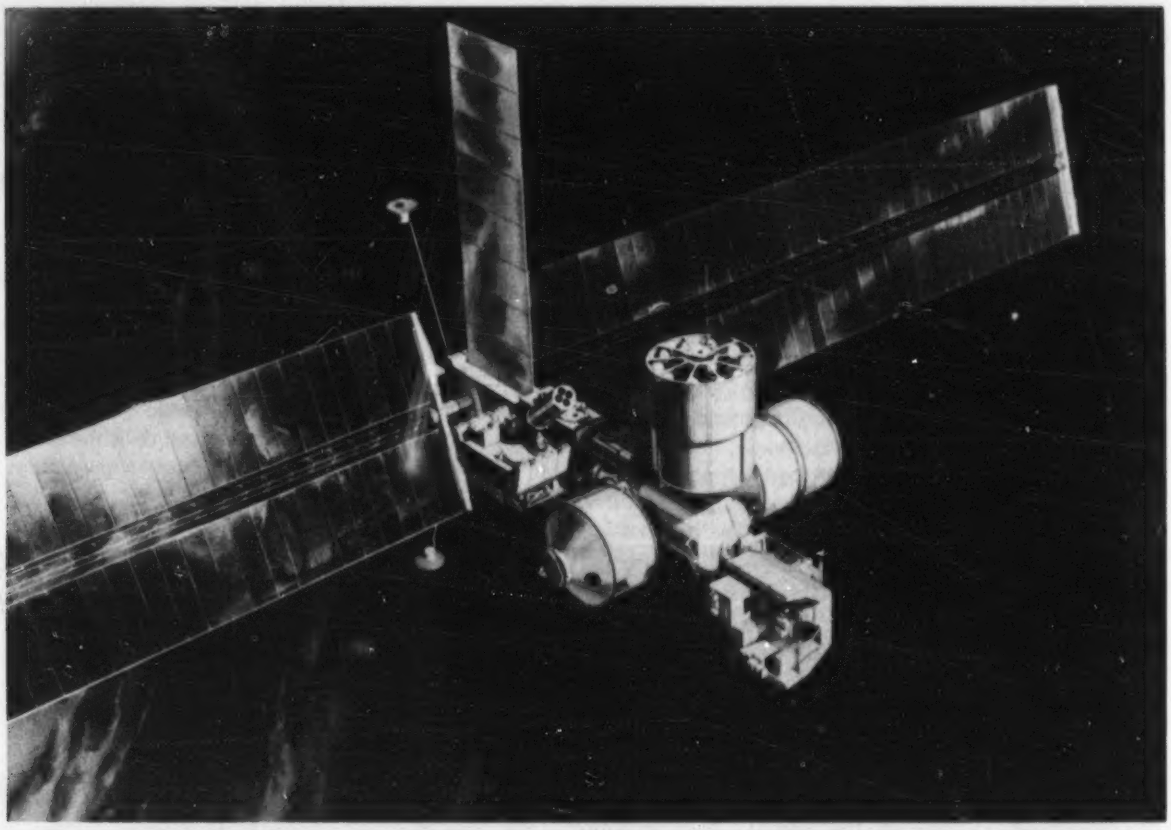
The United States has been characterized as a frontier nation—a country built upon a heritage of meeting new challenges. America's final frontier is space: the current challenge is full and routine utilization of this frontier for the benefit of all the people of our planet.

With the technology of the Space Shuttle, the United States is capable of routine access to space and back. A space station, designed as a permanent facility in orbit around the Earth capable of performing a variety of scientific and operational missions, will be the key that unlocks the second phase of the challenge—expansion of our knowledge and technology. The Space Shuttle provides us with the way to carry needed personnel and payloads for the final hurdle in this challenge—to operate in space routinely and permanently, a vital achievement we are striving to reach in the U.S. manned space program.

NASA has the capability to develop, construct and place in orbit a permanent space station by 1990. Skylab, launched May 14, 1973, was our nation's initial step toward a space station but this facility was not designed as a permanent presence. Its three-man crew rendezvoused and docked the Apollo command module with the Skylab space station on three different occasions with mission stays of 28, 58 and 84 days. Skylab demonstrated that men could function in space over extended periods of time. A permanent space station together with the Space Shuttle would dramatically improve our capabilities to operate in space for both civil and military purposes.

The Soviet Union has already launched a manned space station, Salyut 7, which orbits about 150 miles above the surface of the Earth.

NASA recently has formed a Space Station Task Force to prepare a program for a U.S. space station. The program will begin with mission analysis requirement studies submitted by several major aerospace companies. These studies are intended to define with specificity the various scientific, commercial and defense missions that could be conducted by a space station.



McDonnell Douglas Astronautics Co., reference concept for a space station under study contract to NASA's Marshall Space Flight Center, Huntsville, Ala. Shown is this concept taken to one of its potentials as a manned structure composed of communications antennae, two solar arrays, space radiator, rotating pallets capable of holding space science and applications payloads and an airlock joining two manned modules and a logistics module.

As of the present, just what a U.S. space station would look like is not yet certain. However, prior to formation of the Task Force and as part of NASA's advanced programs, several reference concepts for a space station were studied. One approach, under contract at Marshall Space Flight Center, Huntsville, Ala., is a "space platform concept"—a permanent facility designed to provide core services required of an orbiting spacecraft such as attitude control, power supply, communications, data management and thermal management. This space station concept would support science and applications experiments, either as a group or individually. Taken to its full potential, an air lock assembly could be added joining several manned modules.

A second space station approach that NASA has studied under contract to Johnson Space Center, Houston, begins as a manned facility designed to service satellites in orbit, assemble large space structures and stage launches into higher orbit as well as support science and applications experiments.

Basic elements for a U.S. space station emerged from these reference studies as well as from previous space station studies conducted by NASA:

(1) the design will be modular and expandable;
(2) it will be Shuttle launched and Shuttle tended;
(3) it will have a manned capability;
(4) it will have a national security dimension;
(5) it will have a re-boost capability enabling it to remain in orbit as a permanent structure;
(6) international participation in its development will be encouraged.

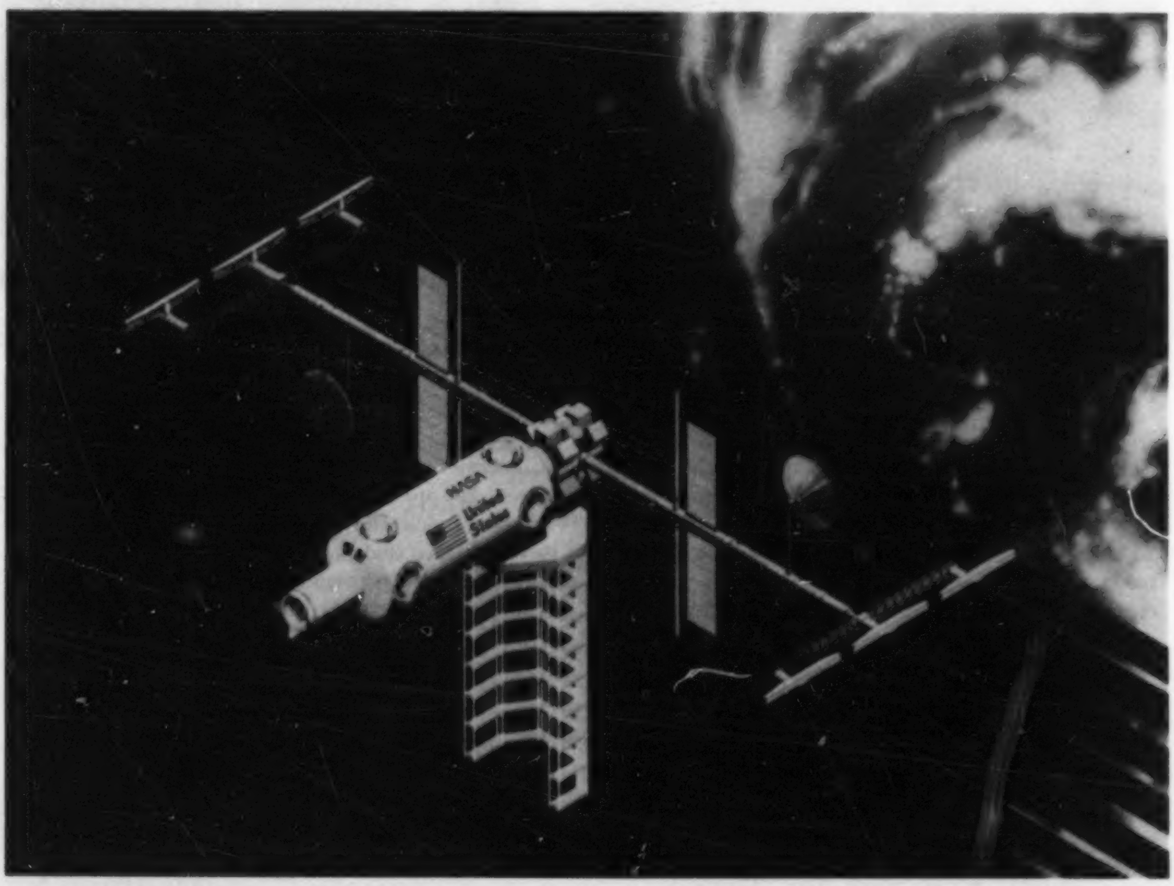
Currently there exists no precise cost data on the construction of a U.S. space station because no specific space station architecture or configuration has been decided upon. However, we believe that the initial phase of a small permanent facility could be placed in low Earth orbit for approximately $3-5 billion over a period of several years.

The President in his Independence Day address (see page 13 of this issue) stated that the "United States must look aggressively to the future by demonstrating the potential of the Shuttle and establishing a more permanent presence in space."

And in his new national space policy, also issued July 4, 1982, the President reaffirmed NASA's commitment to space station technology by stating "the United States Government programs shall continue a balanced strategy of research, development, operations and exploration for science, applications and technology," listing among the objectives of these programs ". . . to explore the requirements, operational concepts and technology associated with permanent space facilities."

With the formation of the Space Station Task Force, NASA has begun to focus on this effort. I stated in a major space station address (see page 21 of this issue), "three factors make a space station a logical step in mankind's inevitable evolution into a space-faring civilation:

> it would build on the capability of the Shuttle to exploit the human presence in space effectively and economically;
>
> it would give us a place to do essential work in the areas of space science and exploration, technology development, space applications and national security;
>
> it would enhance national pride at home and national prestige abroad. The Shuttle has done this for us today. The space station can do it for us tomorrow."



Space station reference concept under contract study by Grumman Aerospace Corp., and The Boeing Co., to NASA's Johnson Space Center, Houston. This concept, termed a "space operations center" is a manned space station. This particular space station is composed of an energy section comprised of solar array panels, radiators, and communications antennae, a data management command module (center) and a science module (top module). The platform extension hanging from the center module is an orbital transfer vehicle hangar.

Why the United States Needs a Space Station

Speech delivered by NASA Administrator James M. Beggs, Detroit Economic Club and Detroit Engineering Society, June 23, 1982

George Santayana once said: "Those who cannot remember the past are condemned to repeat it."

This is as true today as it has been throughout our history. Because we have learned from the past we have maintained the forward thrust of our young civilization. Indeed, young people are often the first to recognize this fact.

A few years ago a professor at the Wharton School of Finance tried an exercise to promote more crisp and concise expression among his students. He asked them to sum up in two words the outstanding characteristics of American society. What, in other words, has made us tick as a nation?

The best answer came from a young woman. Her two words were "we advance."

The key to that advancement, I believe, lies in the fact that we have a continuing urge to chart new paths and to explore the unknown. And that is the hallmark of any great nation.

That instinct drove Lewis and Clark to press across the uncharted continent. It guided Admirals Peary and Byrd to the icy wastes of the Poles. It drove Lindbergh alone non-stop across the Atlantic and sustained 12 Americans as they walked on the Moon.

The compulsion to know the unknown built our Nation. It impelled the pioneers to extend our frontiers across the wilderness to the Pacific. It was the compelling reason behind the "Yankee ingenuity" that increased our commerce and world trade. It moved our businessmen and our farmers to apply new technology to raise the productivity of our farms, factories and transportation systems. It challenged our leaders to develop dynamic new corporate, labor and governmental institutions. And it spurred the creativity of our scientists and engineers so that today, we lead, and are indeed, envied by the rest of the world in science and technology.

It is clear that if we ever lose this urge to know the unknown, we would no longer be a great nation. We must continue to advance the frontiers of knowledge. Nowhere is that challenge greater than in the continuing exploration of the last frontier—that of space.

Increasing our knowledge of the near-earth environment, the solar system and the universe will eventually help us to unlock the puzzle of why and how we came to be and what our future destiny might be. The spectacular photos of Saturn and the data returned from the remarkable journeys of the Voyager spacecraft have already taught us more about that planet than we knew from centuries of recorded observations. Moreover, in space there are real resources and opportunities for commercialization and industrialization. And space holds the promise of eventual human habitation on a permanent basis.

At NASA we are stretching our horizons to encompass all of these mighty challenges.

In the short lifetime of my agency, which stretches back only 24 years, we have come from an aeronautical base into a magnificent new era of space transportation with the Space Shuttle. This world's first reusable space vehicle, will give us routine, reliable and economical access to and from lower earth orbit and will provide the first step to similar access to geosynchronous orbit, lunar orbit and beyond, to the true exploration of the solar system itself. Its three test flights have proved that the concept is extremely sound. We are expecting to learn more about the Shuttle and its capabilities in its last test flight in just four days. And in November of this year it will begin operational service as the true workhorse of space transportation.

We are proud of the successful performance of this remarkable aerospacecraft and look forward to the time when it will demonstrate its versatility to the utmost—as a launch vehicle, as a spacecraft, as a base for scientific research, as a transport for commercial spacecraft, as a repair facility for satellites in trouble, and as the provider of routine roundtrip transportation to and from space.

Needless to say, we are also heartened by public backing for the Shuttle program. A recent Associated Press/NBC News poll indicated that 60 percent of the public believe the Shuttle is a good investment for America. Other polls tell us that 40 percent of the public think that the United States should be spending more on the space program. This is the greatest public support in the history of the agency—higher even than in the halcyon Apollo years, when we were very popular.

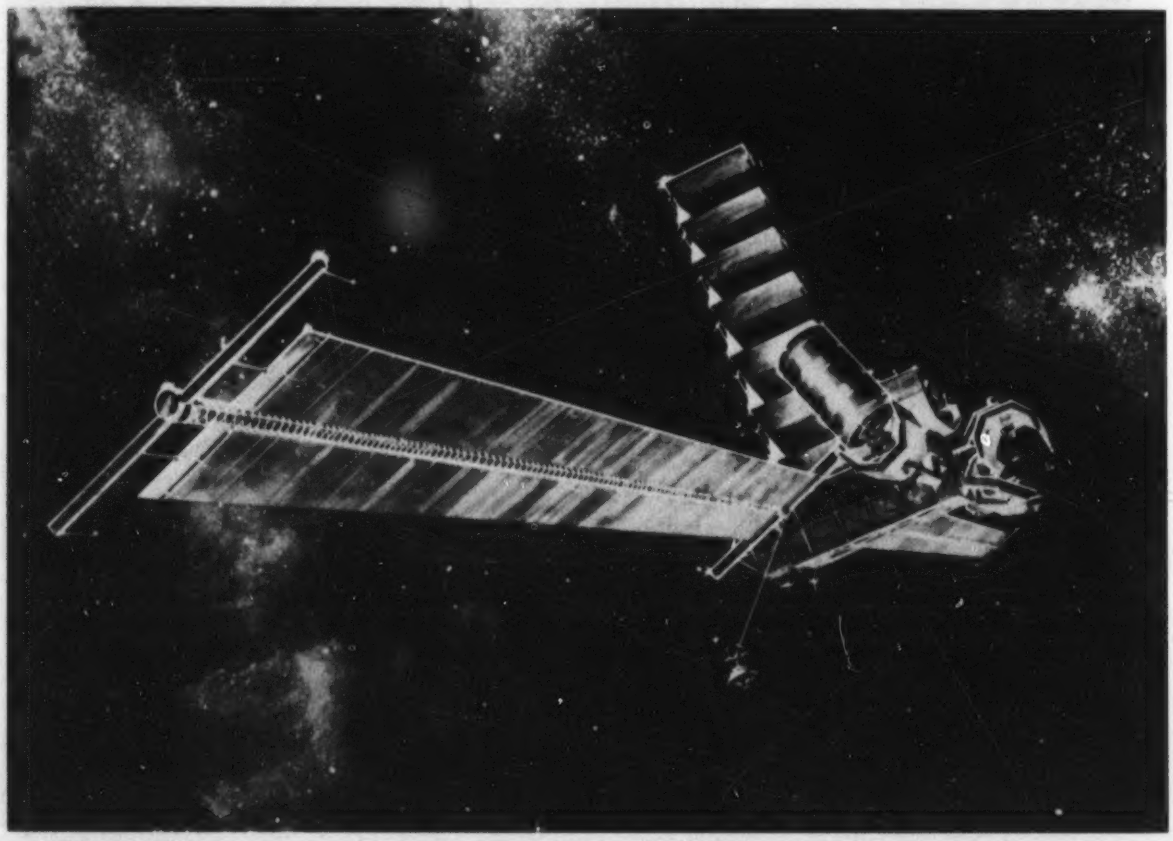
To me this support means two things. The first is that Americans are becoming increasingly aware of how crucial a vigorous high technology program is in keeping us ahead of our competitors in space. The second is that there is a growing realization that the national investment in the type of research and development that NASA does so well is more than worth it. The payoffs include new industries, new jobs, new products, new knowledge and a new spirit of national pride. Indeed, many have argued that the single transfer of NASA-developed communications satellite technology alone could suffice as payoff for our entire expenditures on the space program to date.

I am pleased that President Reagan and his Administration fully understand how important our work is to the nation. Even in these times of budget austerity, Administration support is strong. It resulted in a request for an eleven percent increase in real-year dollars over last year in NASA's Fiscal 1983 budget. This means that the Administration is committed to bringing the Shuttle to full operational capability and will support progress in all NASA major program areas.

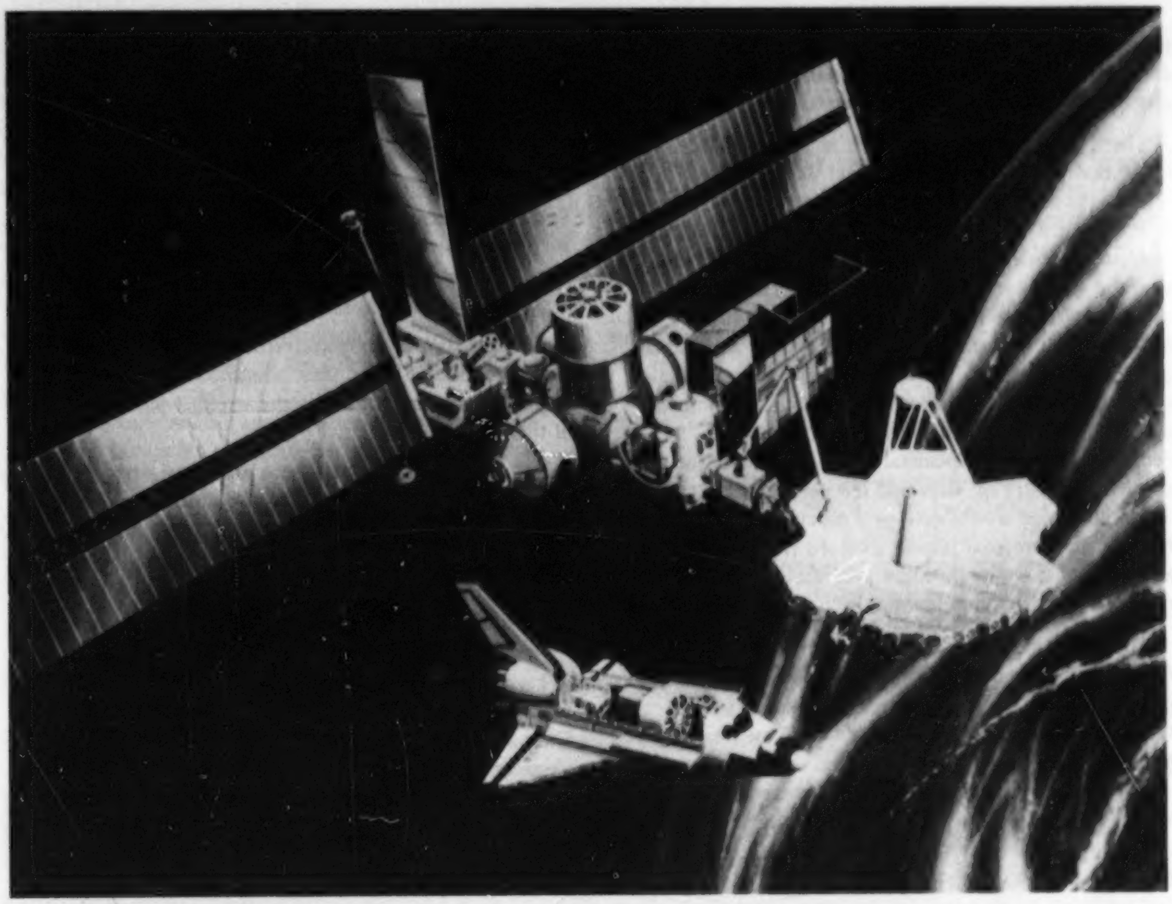
In a few years a fleet of at least four Shuttles will be flying routinely to and from space, ferrying into orbit commercial, scientific and national security payloads. The Shuttle has given us a head start in the commercialization, utilization and exploration of space. But as we look to the future, we must begin to secure that leadership in space through the end of the century and beyond. The way to do this is to set a fruitful new direction for the space program, one which would make the best use of the Shuttle's capabilities. And the time to do it is now.

I believe that our next logical step is to establish a permanent manned presence in low-Earth orbit. This can be done by developing a manned space station. At NASA we have begun to focus on that goal. We think that such a station could be built and placed in orbit by 1990. It would be small at first, assembled in orbit with modules carried to space by the Shuttle. Once there, the station would make a vital contribution to our nation's future, by opening new vistas of science and technology, new possibilities for commercial applications of space, and new opportunities to enhance economic security and the national defense.

To many, the idea of a space station may seem a bit far-fetched, an esoteric science fiction fantasy that could only be realized centuries from now. But they forget that once before the United States developed and launched a space station, although one not designed for



TRW reference concept for a space station studied under contract to NASA's Marshall Space Flight Center, Huntsville, Ala. Shown is TRW's unmanned space platform concept shown from an underside view. This particular space station is composed of communications antennae, two solar arrays, space radiator and several rotating pallets capable of holding space science and applications payloads. This platform concept taken to full development could include an airlock assembly joining several manned modules.



Reference concept for a space station that features a modular space platform of rotating pallets containing space science and applications payloads with airlocks joining three manned modules. At lower center, the Space Shuttle hovers near a large antennae platform.

a permanent presence in orbit. It was called Skylab and it was launched almost ten years ago, in May of 1973.

Skylab served as home for nine astronauts during its active life of 1½ years in orbit. On three separate occasions, men lived and worked in this U.S. space station for periods of 28, 58 and 84 days. Skylab not only demonstrated that humans could function comfortably and effectively in space for extended periods, but it showed how important man is to our activities in space. On several occasions astronauts had to perform critical repairs on the spacecraft, both internally and externally. Indeed, the Skylab program nearly failed on its launch day but a skilled flight crew was able to rig an emergency thermal protection system and then two astronauts went outside the spacecraft to release a stuck solar array. These repairs permitted the mission to continue as originally planned.

Skylab also demonstrated the utility of an orbiting scientific laboratory. Its eight different solar telescopes greatly increased our knowledge of the sun, the stars and the galaxies; its Earth-sensing instruments revealed data about our Earth otherwise unobtainable.

Now that we have the Space Shuttle, we owe it to the nation to make optimum use of this new capability of routine and reliable access to and from space. What better way to make full and complete use of the Shuttle than to develop a manned space station in orbit tended and supplied by the Columbia and her sister ships?

In fact, the Shuttle program originally was conceived to include a space station. More than a decade ago a total system was envisaged in which the Shuttle would transport payloads routinely to such a station. Today we see the station functioning in many roles. It would serve as a scientific laboratory, as a space operating facility for assembling, resupplying and servicing satellites, and for launching spacecraft to higher orbit. And, of course it would play a role in national defense.

No doubt the Australians will be glad to hear that this time the station would have a reboost capability and controlled deorbit mechanism to enable it to stay in space for as long as we want it there.

There is much to do and much to learn in space—much that we would like to do and would be able to do with a space station. With a permanent human presence in orbit, we will much more effectively support those instruments which will probe further and further in space in our quest to more thoroughly understand our universe. We would look down, and, through the technology of remote sensing, improve our understanding of our own Earth, the natural resources it possesses and the impact of man upon those resources. With a space station, we would find it easier and more economical to launch planetary probes to study the surface chemistry of Mars and the geology of Venus. This knowledge would give us a much better idea of how all the terrestrial planets evolved from the solar nebula so that we might more accurately chart the course of Earth's future evolution.

The space station would serve as the assembly point for manned or unmanned missions to Mars and for probes to the asteroids and comets, which scientists believe contain a chemical record of the evolutionary phases of the solar system. With the station, ultimately, we could send to the nearby planets unmanned probes which could be programmed to return samples of planetary surfaces. Analysis of these samples would help us better to understand why life evolved on Earth and probably nowhere else in the solar system.

There are exciting and important opportunities, too, in commercial applications research in a space station.

Commercial applications of space technology, such as materials processing development and communications satellites, hold promise of development into markets far beyond those we see today. And many will see their origins in a space station of the type we have in mind. The span of these commercial possibilities is limited only by the boundaries of our imagination. And these boundaries would be vastly expanded by the experience we will gain from early use of the space station.

The development of a space station would also open new opportunities for international cooperation in space. Indeed, a space station could be the logical catalyst for a great new international cooperative venture for the Free World. It could serve to focus the intense interest and capabilities in space that our allies in Europe and this continent as well as in Japan already have. And it could provide a mutually beneficial cooperative project to cement Free World ties.

We already have a long history of international cooperative ventures in space stemming from the 1958 National Aeronautics and Space Act, which created NASA. Already we have more than 1,000 agreements with over 100 nations covering the full range of cooperative activities. Among the most visible of these are the $100 million Canadian-built Remote Manipulator System, the essential remote arm of the Shuttle; and the $1 billion European-built Spacelab, an orbiting laboratory which will be launched next year in the Shuttle's cargo bay.

An international cooperative effort on a space station would continue to link other countries' space programs to the Shuttle, strengthening the overall space program of the United States.

But as you and I know, there are many who would decry a new program of expansion into space. They would argue that we cannot afford to apply our limited resources to such goals as space stations and the like. The problems we face on Earth, they say, must come first; and never mind the planets and the stars. They will always be there.

I would remind these nay-sayers of the lessons of history. Since 1957 when Sputnik first shocked the United States into a space program, we have not been alone in space. Today although we still lead the world in space technology, and the Shuttle gives us perhaps a decade of breathing space to maintain that leadership, we have been joined by many nations and we now face growing and serious competition in space.

That competition comes not only from our friends in Europe and Japan, but from the Soviet Union, which has repeatedly stated its intention to construct a permanently manned orbital facility.

Although many tend to debunk Soviet technology and accomplishments in space, the Russians already have demonstrated an impressive operational space station capability. Their Salyut 6, presently unmanned, was launched in 1977, and was home to five main crews and eleven visiting crews from Eastern Europe, Cuba and Vietnam. Indeed, the Vietnamese cosmonaut who flew aboard Salyut 6 has more flight time in space than our second Columbia crew—Joe Engle and Dick Truly—combined. Salyut was resupplied periodically by the unmanned Progress spacecraft, an impressive technological achievement. And its crews were busily engaged not only in military activities, but in such civil functions as remote sensing, materials processing, space biology and medicine, astronomy and astrophysics.

The Soviets recently launched Salyut 7, to replace Salyut 6. Salyut 7 is now occupied by cosmonauts and has been reported to represent a larger, more sophisticated system that would move the Soviet Union another step forward in its quest for dominance in near-Earth space. It is imperative that the United States and the Free World meet that challenge effectively and soon.

To paraphrase Shakespeare, if "we do not take the current when it serves," we will "lose our ventures." I believe the current serves us well now. The door to space has been opened and it could no more be slammed shut than could the doors opened by Gutenberg's printing press, Galileo's telescope, Fulton's steam engine or the Wright Brothers first flight. And that door leads inevitably to the extension of the human environment into space.

Three factors make a space station a logical step in mankind's inevitable evolution into a space-faring civilization.

The first factor is that the station would build on the capability of the Shuttle to exploit the human presence in space effectively and economically. It would represent a major step towards the goal of true exploitation of the opportunities which space provides for improving our nation's position in the world and for improving the quality of life for all mankind.

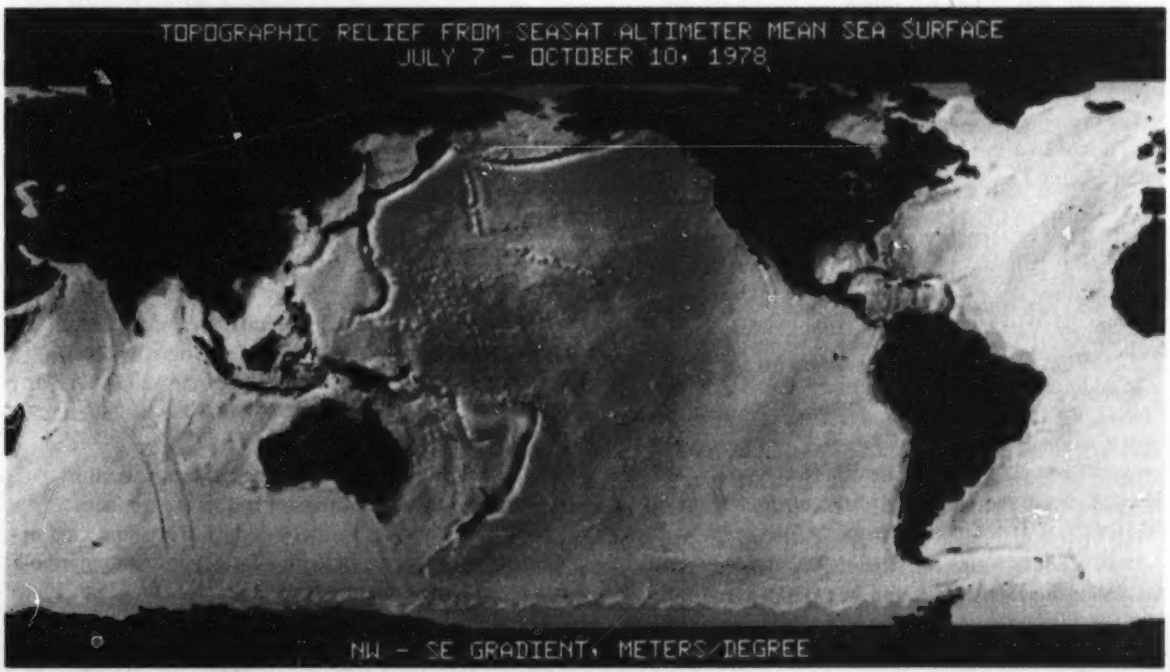
The second factor is utility. The space station would give us a place to do important, indeed, essential work in the areas of space science and exploration, technology development, space applications and national security. Space, we now know, is not just a place to visit. It is a place to work.

The third factor is one less tangible, but equally important. As a highly visible permanent United States presence in space, a space station would serve to enhance national pride at home and national prestige abroad. The Shuttle has done this for us today. The space station can do it for us tomorrow.

More than two hundred years ago, when our Nation was founded, we were weak in arms, poor in goods, but rich in spirit. Thomas Jefferson was able to say then after he drafted the Declaration of Independence that "we act not just for ourselves alone, but for the whole human race."

Today, the United States is strong in arms and rich in goods and still rich in spirit. We have built a magnificent new Space Transportation System. It holds unlimited opportunities for reinvigorating our economy, inspiring our youth, amassing new scientific knowledge, strengthening our defense and enhancing our national pride and prestige.

And we have an opportunity to act again, not just for ourselves, but for the whole human race.


TOPOGRAPHIC RELIEF FROM SEASAT ALTIMETER MEAN SEA SURFACE
JULY 7 - OCTOBER 10, 1978
NW - SE GRADIENT, METERS/DEGREE

100 Days of Data—Topographical map of the ocean produced from altimetry data from NASA's Seasat oceanographic satellite, launched in 1978. All the major differences of the world's ocean floor are reflected here as height differences on the sea surface. The map, comprised of 100 days of Seasat data, was produced by Jet Propulsion Laboratory oceanographer Dr. Michael Parke. Seasat was managed for NASA by JPL, Pasadena.

Four Moons of Uranus Measured For The First Time

Four of the five known moons of Uranus have been measured for the first time by University of Hawaii astronomers working under NASA grants. Uranus, nearly 3 billion kilometers (about 2 billion miles) from Earth, can only be seen with a telescope.

Sizes of the moons were determined from measurements of their infrared, or heat, radiation taken by NASA's Infrared Telescope Facility on Mauna Kea, Hawaii. This telescope, the most sensitive instrument in the world for measuring faint infrared sources, was constructed by NASA in part to provide support for spacecraft exploring the planets. The facility is operated by the University of Hawaii under contract to NASA.

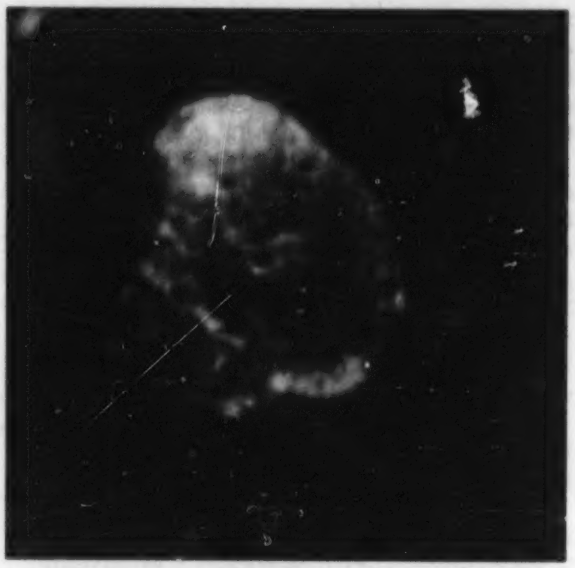
The new measurements reveal for the first time that these moons are large astronomical bodies, with diameters that range up to 1,690 km (about 1,100 mi.) for Oberon, the largest. (The moons of Uranus are all named for characters in Shakespeare's plays). Although smaller than Earth's moon, these objects are as large as any of the moons of Saturn, except for giant Titan, the only planetary satellite with a major atmosphere.

The new measurements also reveal that the moons of Uranus are darker than the bright icy Saturn moons investigated by Voyager. This result was a surprise to many scientists, who had suspected that the moons of Uranus might also be bright.

The presence of water ice on the Uranus moons had been discovered from astronomical observations carried out at Mauna Kea several years ago. The brightness and colors of the surfaces of the Uranus moons resemble closely those of Hyperion, one of the smaller moons of Saturn. It is believed that Hyperion's surface is composed of dirty ice—ice contaminated by darker material that may have formed at the time the planets were created.

In addition to the measurements of the moons of Uranus, the Hawaii researchers report that Triton, the largest moon of Neptune, and the planet Pluto, are both too small and cold for their heat radiation to be detected. From the weakness of these sources, they calculate that Triton must be smaller than Earth's Moon.

Dr. Dale R. Cruikshank, who has been studying Pluto and Triton for many years and was the discoverer of methane ice on the surfaces of both objects comments that these new results effectively eliminate the possibility that Triton is a giant moon, perhaps even the largest moon in the solar system. He says that both Triton and Pluto appear to be cold, icy objects of sublunar size. "Based on our current knowledge, they may be physically very similar to each other." There has been speculation in the past that Pluto might be an escaped moon of Neptune.



Voyager 2 closeup view of Saturn's satellite Hyperion taken from a distance of about 500,000 kilometers (300,000 miles).

NASA's Voyager 2 spacecraft is now headed for Uranus following its successful flyby of Saturn 10 months ago; scheduled arrival at the distant planet is 1986.

Pioneers May Find Tenth Planet, Dark Star Or Black Hole

NASA's two Pioneer spacecraft, the most distant manmade objects in the solar system, may be able to detect a 10th planet out beyond Neptune and Pluto—or alternatively a dark star companion to the sun at perhaps 50 billion miles beyond Pluto.

The Pioneers have unique advantages for such a search, and persistent irregularities in the orbits of Uranus and Neptune strongly suggest that some kind of mystery object is really there—far beyond the outermost planet. (Because Pluto's orbit is greatly elongated, Pluto and Neptune take turns being the outermost planet with Pluto currently inside Neptune's orbit for the next 17 years.)

Pioneer 10 is now between the orbits of Uranus and Neptune and will be beyond all the planets in July

1983. Pioneer 11 is between the orbits of Saturn and Uranus.

Primary mission of the Pioneer spacecraft, which are managed by NASA's Ames Research Center, Mountain View, Calif., was flybys of the planet Jupiter. Pioneer 10 was launched in March 1972 and made its closest approach to Jupiter in December 1973; Pioneer 11 was launched in April 1973 and made its closest approach to Jupiter in December 1974.

The discovery in 1978 of a satellite of Pluto (since named Charon) reduces the calculated mass of the Pluto-Charon system to only one fifth the mass of the Earth's moon, and gives Pluto a diameter of 1,400 kilometers (1,500 miles). This is far too small mass to account for the unexplained tiny but regular shifts in the orbits of Neptune and Uranus. These orbital changes had been attributed to the pull of Pluto's gravity on the two planets.

A large dark-star type object (perhaps the size of the sun) and perhaps 50 billion miles beyond the outermost planet could produce the orbit shifts measured for Neptune and Uranus. This distance from the sun is a common one for dark stellar companions of visible stars.

A black hole, perhaps 10 times the sun's mass and twice as far out (100 billion miles beyond Neptune) also could account for the measured orbit shifts.

Either of these two types of objects would produce a general tidal effect in the solar system (an equal gravitational pull) on all the outer planets.

On the other hand, the pull of an undiscovered planet-sized object at perhaps 5 billion miles beyond Pluto and Neptune would also be consistent with orbit discrepancies for Neptune and Uranus. But these would be "local effects," and gravitational pull would vary markedly with planetary positions.

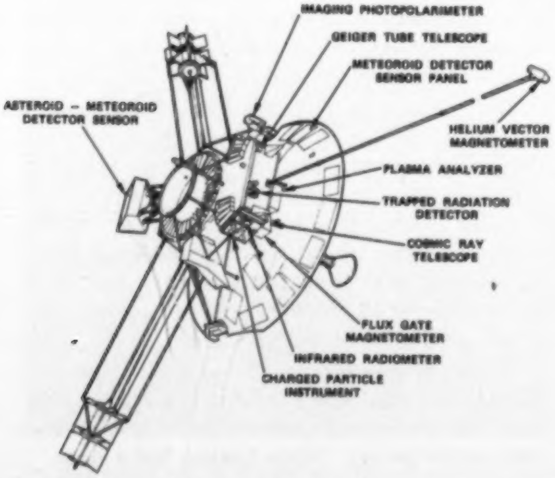

IMAGING PHOTOPOLARIMETER
GEIGER TUBE TELESCOPE
METEOROID DETECTOR SENSOR PANEL
ASTEROID – METEOROID DETECTOR SENSOR
HELIUM VECTOR MAGNETOMETER
PLASMA ANALYZER
TRAPPED RADIATION DETECTOR
COSMIC RAY TELESCOPE
FLUX GATE MAGNETOMETER
INFRARED RADIOMETER
CHARGED PARTICLE INSTRUMENT

Diagram of NASA's Pioneer 11 spacecraft illustrating the various experiments carried aboard.

Since Pioneers 10 and 11 are on opposite sides of the solar system, one spacecraft would feel the pull of a "small and close" planet-size object far more than the other would. A larger, more distant body would pull on both spacecraft almost equally. Therefore, measurements of the solar system escape trajectories of the two spacecraft over periods of several years could be used to find out whether the Pioneers were being attracted by a relatively close planet versus a more distant dark star or black hole. Further observations would allow estimates of size and distance of such a planet as well as its direction. Calculations for this would be based on changes with location in space of the gravity field created by such an outside-the-known-solar-system body.

If the Uranus-Neptune orbit changes turned out to be due to a dark companion star or black hole, presence of such a large body could be verified, and a line through the sun and solar system could be drawn, which would also pass through the large "mystery body." However, it would not be possible to say from Pioneer data which of two sides of the solar system the body was on. Other types of measurement aimed at locating such a big object might soon be developed, once its presence was known.

While almost any dark celestial object is a possibility, Dr. John Anderson of NASA's Jet Propulsion Laboratory, Pasadena, Calif., Pioneer celestial mechanics experimenter, suggests that perhaps a dark stellar companion to the sun might be the most likely explanation. A 10th planet should be at least 5 billion miles beyond Neptune, unless it were completely out of the pattern of spacing (distances from the sun) for the other solar system planets (Bode's law). At this distance to produce the measured effects on Uranus and Neptune, it would have to be another giant planet, as large as Uranus (diameter, 47,300 km or 29,400 mi.) or Neptune (distance, 43,130 km or 26,800 mi.). If a 10th planet were still farther out, it would have to be even larger, on the scale of enormous Jupiter. Such a large body should be easily visible by telescope, and would have been discovered already. However, if the surface of such a giant planet (of either size) were very dark (unreflective) or far out of the plane containing the other planets, it might be hard to detect visually, and still be undiscovered.

Black holes, so far, are somewhat exotic objects, and only one black hole has been tentatively identified, while dark stellar companions to stars like our sun appear to be relatively common.

"There is a whole class of objects ranging between a planet and a dark star. It could be any of these, and we are keeping an open mind," says Anderson. "We know there is a source of systematic variations in the orbits of the two outer planets.

"Work demonstrating these orbit variations has been done largely at the U.S. Naval Observatory, the Massachusetts Institute of Technology and NASA's Jet Propulsion Laboratory."

These Pioneer measurements should be much more effective than continuing measurements of outer planet orbits, since at the least 30 to 50 years of observations would be required, and probably several complete orbits. Pluto requires 249 years to complete an orbit, Neptune, 165 years, and Uranus, 84 years. All these are time periods so lengthy that they provide difficulties for practical observations. Several years of Pioneer measurements should provide essentially the same information.

The Pioneers have a further advantage as they are stabilized by their five rpm spin, rather than by the orbit-changing push of thruster systems. This means their precisely-known trajectories are shaped almost entirely by natural forces, and have been for many years.

Anderson believes measurements of the Pioneer orbits could detect a gravity force from outside the solar system as minute as one trillionth kilometer per second per second, or even one ten trillionth (Earth's gravity, at the surface, its equal to one hundredth km per second per second).

Measurements of Pioneer's position are made by two-way Doppler. A two-way radio signal is sent to the spacecraft at a known frequency. Changes in frequency of the returning signal due to the "Doppler effect" give changes in spacecraft velocity away from Earth to a fraction of a millimeter per second. Plotted continuously, these velocity changes give the exact spacecraft trajectory relative to the known exact locations of the Sun and planets. Unexpected velocity changes suggest the presence of another body.

Celestial mechanics methods (like those just described) have been used to find other outer planets. Differences between the real orbit of Uranus and its calculated orbit led to finding Neptune in the 19th century. Percival Lowell and William Pickering used Uranus-Neptune data to compute a hypothetical orbit for Pluto, although Clyde Tombaugh actually found Pluto in 1930 through a painstaking search of thousands of star photos.

"Slippery" Wings Smooth Way for Business Plane Fuel Savings

An aerodynamics advancement once thought to be impractical for powered aircraft may be practical after all, according to evidence gathered by a research team at NASA's Langley Research Center.

The smooth and aerodynamically clean lines of many airplanes developed since World War II may offer previously unrecognized advantages in performance and fuel efficiency that many older aircraft, with their protruding rivets and surface imperfections, cannot easily match.

The advantage results from a phenomenon called laminar flow. An airplane which achieves laminar flow can slip through the air with less effort, which can either increase speed or save fuel.

Airflow close to the surface of a wing or other smooth object is called laminar when its layers are thin and uniform and slide easily over each other, delaying the onset of drag-producing air turbulence.

Considered an intriguing opportunity as a result of wind tunnel and flight tests in the 1930s and 1940s, natural laminar flow proved to be extremely difficult to achieve on conventional riveted aluminum airplane designs. After several attempts by powered airplane manufacturers to capitalize on laminar flow, interest faded.

Unpowered sailplanes, however, had been exhibiting natural laminar flow at cruise speeds approaching that of powered light planes for some time. Sailplanes slice through the air efficiently because their shapes are aerodynamically good, and because they are made with plastic composite skins of fiberglass or kevlar which can eliminate waviness, rough body joints and other obstructions which destroy laminar flow.

Researchers at Langley recently predicted that modern construction techniques, developed since early NACA (National Advisory Committee on Aeronautics, predecessor to NASA) tests, now allow full-sized wings to be built that approach the smoothness of highly accurate wind tunnel scale models and flight test wings that demonstrated laminar flow 40 to 50 years ago. In the past several months, flight tests have been conducted which substantiated these predictions.

"I think many people will be surprised at our findings," said Dr. Bruce Holmes, of Langley's Subsonic Aerodynamics Branch and one of several researchers on the project. "While Langley had a clean-looking, full-size lightweight airplane made of fiberglass in the 9-by-18-meter (30-by-60-foot) tunnel last year, several of us thought it a good opportunity to check for laminar flow. We put chemicals on all the wing surfaces, allowing us to visually determine the extent of laminar flow. The flow proved to be laminar on the lifting surfaces studied in the tunnel.

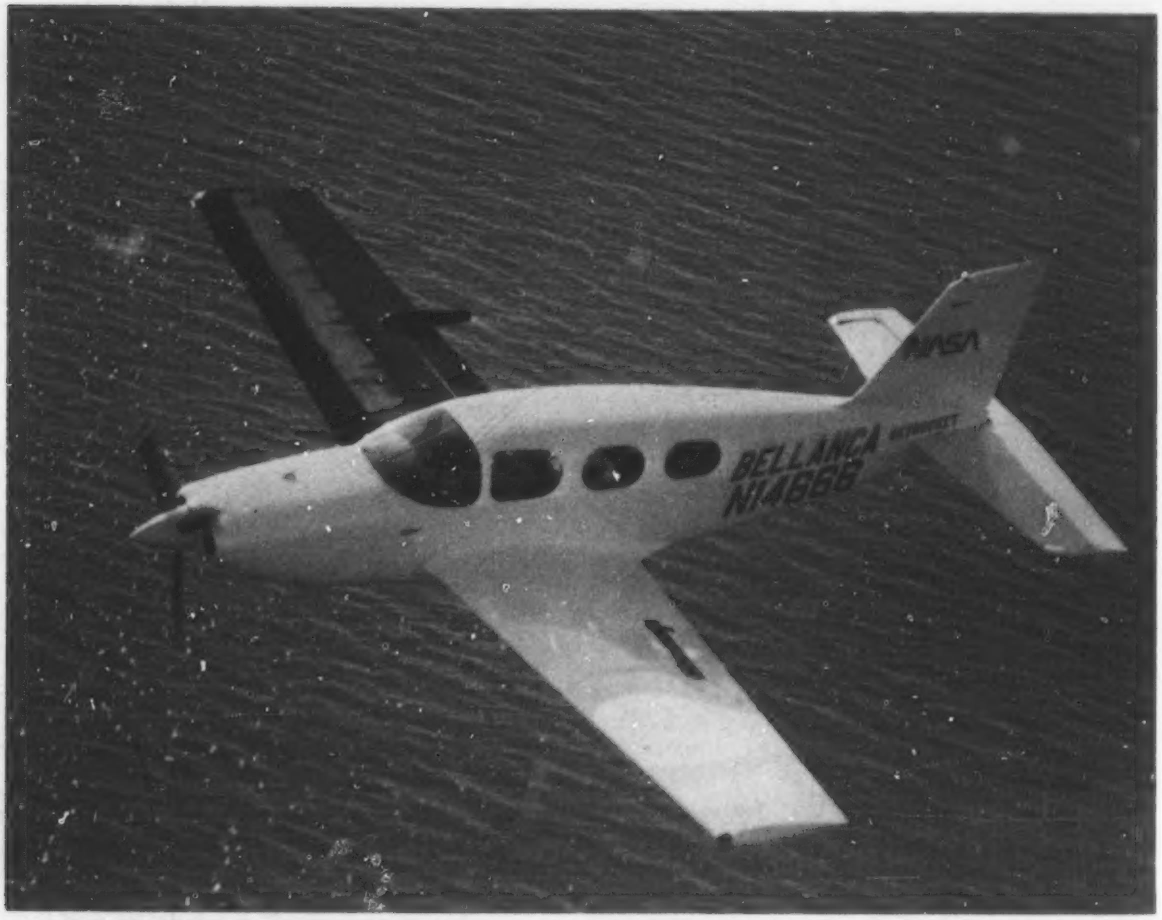
"That's when we took it a step further and tested eight actual flying aircraft, ranging in size from small two-place, propeller-driven, home-built airplanes up to a twin-engine business jet. All were aerodynamically efficient aircraft, and the flight tests proved that a significant part of their efficiency was due to the achievement of laminar flow, reducing drag by an estimated 25 percent in some cases," said Holmes.

Making use of construction methods developed since the 1950s, these airplanes have either bonded wing skins made of aluminum, integrally stiffened milled skins of aluminum or skins made of composites. Beneath the skins, wing substructures can vary greatly and represent another important area of advancement.

As a result, wing construction techniques have changed enough since the early wind tunnel work to allow modern wings on general aviation airplanes to achieve laminar flow.

Applications could go beyond the smallest of airplanes to business transports and commuter airliners, provided some crucial operational problems can be solved. For example, small amounts of ice buildup could cause large increases in drag on laminar flow wings.

More pervasive is the possible disturbance of the airflow by insects. "Wherever insects hit and stick, they may interfere with the smoothness of the boundary layer of air. What you want to do is to keep ice and insects



The black painted wing on this airplane allows researchers to visualize chemicals applied to measure natural laminar flow and its effects on airplane performance. The Bellanca Skyrocket II is constructed of fiberglass composite materials, providing an aerodynamically smooth surface. The chemical pattern shows laminar flow extending from the leading edge for about the first 50 percent of the wing's surface. Capable of speeds in excess of 300 miles per hour, the Skyrocket, a prototype business plane, is shown in test flight over the James River in eastern Virginia.

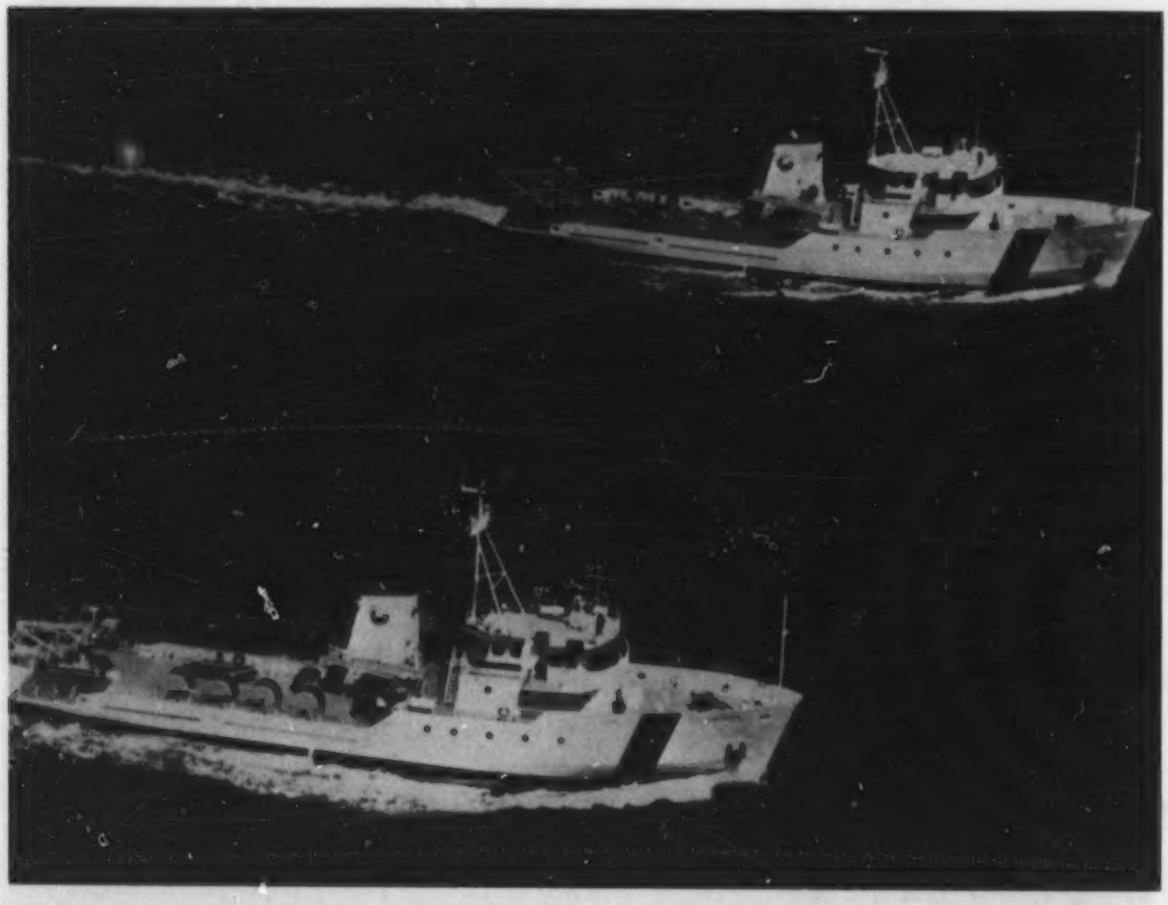
from sticking in the first place," Holmes says. Rain can temporarily do the same thing, as proven in flight and in wind tunnels. Tests are planned during the next year to evaluate concepts intended to eliminate ice and insect-sticking problems on laminar flow wings.

The additional effort to keep the wing and other lifting surfaces clean should be worthwhile. The payoff in fuel efficiency promises to be high. About half of the total drag on an airplane at cruise speeds is caused by friction between the air and the airplane skin surface. Explains Holmes, "That friction can be very low with laminar flow. However, if the flow is turbulent, that friction can be as much as seven or eight times greater."

Taking full advantage of maximum laminar flow will probably require new airplane designs, according to Holmes, because the same slippery qualities that can make wings aerodynamically efficient can be applied to the fuselages of certain designs as well.

Booster Hardware Set for Reuse on STS-5

Whatever happened to the reusable solid rocket boosters that helped lift the Space Shuttle from its launch pad on the first, second and third Shuttle flights? According to NASA's Vince Caruso of the Marshall Space Flight Center, in Huntsville, Ala., all six of the boosters are in various stages of refurbishment and are almost ready to be used again. Because refurbishment processing times differ for the various components of

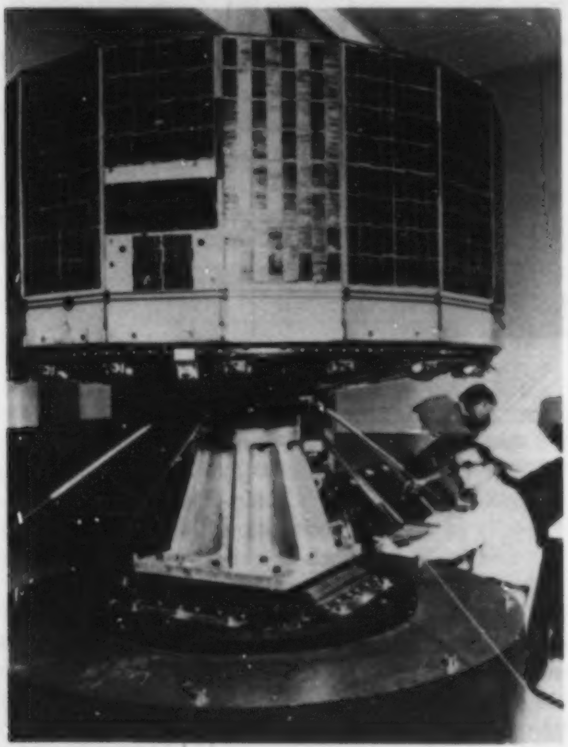


NASA's Navy—Solid rocket booster retrieval ships, the UTC Freedom (foreground) and the UTC Liberty. Each vessel has a displacement of 955 metric tons (1,052 tons) and is equipped with sophisticated communications and navigation systems. The ships retrieve the frustrums and empty casings of the boosters along with the parachutes that have lowered them into the Atlantic approximately 6 minutes 54 seconds after liftoff of the Space Shuttle.

the boosters, some parts will be reused earlier than others.

The first pieces of booster hardware to demonstrate their reusable characteristics will be the parachutes used on the first Shuttle mission. The chutes have been cleaned, checked for any damage and repacked. They are slated for use again on the boosters that will help launch the shuttle on its fifth flight in November.

"Other booster components from STS-1 will be used on successive Shuttle flights," said Caruso who heads the production management and planning office for Marshall's Solid Rocket Booster Project. "The forward skirts and frustums of those boosters will go on STS-6, the aft skirts on STS-7 and the motor segments will fly on STS-8," he said. "Reuse of the boosters from flights two and three will follow the same pattern: the parachutes from STS-2 will fly again on STS-6, and so on."



Billion Mile Space Traveler—First TIROS weather satellite undergoing vibration testing at RCA Astro-Electronics, Princeton, N.J., before launch in April 1960. The satellite transmitted the first weather pictures ever returned from space. Under NASA's direction, RCA built 27 succeeding spacecraft in the series. In 22 years, TIROS (Television Infrared Observation Satellite) satellites have travelled more than nine billion miles and accumulated more than 67 years of useful life in orbit.

Currently some hardware is sent back to the manufacturers to have the work done, but as the Shuttle becomes operational the majority of the work will be done at NASA's Kennedy Space Center, Fla., by United Space Boosters Inc., under the direction of Marshall's resident office located there. The solid motor cases, however, will continue to be returned to the manufacturer to be refilled with solid propellant.

The parachute systems are expected to be reused up to 10 times and the rest of the booster systems about 20 times.

Finalists Chosen in Second Shuttle Student Involvement Project

Twenty finalists have been selected in the second national Shuttle Student Involvement Project, a joint venture of NASA and the National Science Teachers Association. Finalists for this competition were chosen from 196 semifinal entries based on individual scientific or engineering merit for potential assignment on future Space Shuttle flights.

Three student winners from the first national competition have had their experiments flown aboard the Space Shuttle: **Shuttle Flights 3,** March 22-30, 1982, "**Insects in Flight Motion Study,**" developed by **Todd Nelson**, Adams, Minn.; **Shuttle Flight 4**, June 27-July 4, 1982, "**Effects of Diet, Exercise and Zero Gravity on Lipoprotein Profiles**," developed by **Amy Kusske,** Long Beach, Calif., and "**Effects of Space Travel on Levels of Trivalent Chromium in the Body**," developed by **Karla Hauersperger**, Charlotte, N.C. These latter two experiments were medical in nature and required no hardware preparation.

The objective of the national Shuttle Student Involvement Project is to stimulate the study of science and engineering in grades 9 through 12 through a competition to develop experiments suitable for flight aboard the Space Shuttle. NASA pairs each student winner with a corporate sponsor and a NASA scientist or engineer to work with the student to determine the feasibility of developing the proposal into an actual experiment for flight. For those proposals determined to be feasible, a tentative development schedule is established. For those proposals determined not to be feasible, NASA attempts to assign the student to work with a principal investigator as part of an existing research team on a project in the student's field of interest.

Shuttle Complexity—View of the Space Shuttle cockpit shows some of the 1,800 toggle switches, pushbuttons, rotary switches, circuit breakers and other controls needed to fly the spacecraft. Under a study contract with NASA's Johnson Space Center in Houston, Boeing Aerospace Company engineers are designing new multifunction display and control systems which could replace many of these switches. Multifunction systems will help astronauts reduce the training time needed to master this complex assortment of controls.

Interdisciplinary teams of teachers, scientists and engineers reviewed more than 2,800 proposals submitted to 10 regional offices and selected semifinalists. Regional conferences for the semifinalists were held this spring at various NASA field centers.

Semifinalists' proposals were then judged by a national team which selected the finalists. Panelists on the judging team included representatives from the American Association for the Advancement of Science, Educational Resources Information Center, NASA, National Institutes of Health, National Science Foundation, National Science Teachers Association, Uniformed Services University of the Health Sciences, and several universities and consulting firms.

The 20 national winners and their teacher-advisors will attend a special Space Shuttle conference in August at NASA's Kennedy Space Center, Fla. At the conference the participants will receive briefings on Shuttle integration procedures, as well as tour the space center's facilities and view launch preparations for the fifth flight of the Space Shuttle Columbia, scheduled for November.

Most student experiments will be placed in storage lockers in the mid-deck section of the Shuttle orbiter. The mid-deck placement will allow easy astronaut access to the student experiments. As much as one hour of an astronaut's time during the flight may be allocated to work on the project.

Assisted by a sponsor and/or a NASA consultant, the student will analyze the data returned from the experiment and prepare a final report. All scientific data from the student experiments will be in the public domain and made available from the National Space Science Data Center at NASA's Goddard Space Flight Center, Greenbelt, Md.

A third Shuttle Student Involvement Project will open in September with regional conferences to be held in March 1983 with student winners being selected in May 1983. Information on entry procedures can be obtained by writing to the National Science Teachers Association, 1742 Connecticut Avenue, N.W., Washington, D.C. 20008.

The 20 student winners and experiments of the second national Shuttle Student Involvement Project are:

Sara H. Abozeid, Madison, Wisc., "**Testing Chemotaxis in Lumbricus Terrestris in the Absence of Gravity**." The purpose of this experiment is to determine the effects of carbon dioxide-oxygen gradient on chemotaxis in earthworms in the absence of gravity. The objective of the experiment is to see what causes worms to move up and down in the soil.

William S. Akmentins, Appleton, Wisc., "**Test of an Electrostatic Confinement in Space**." This experiment will determine whether an object can successfully be confined to a certain area using electricity in zero gravity, and if so, how much voltage does it take to keep the object in that area.

Sean M. Amberg, Seward, Neb., "**Statoliths in Corn Root Caps**." The effect of weightlessness on the formation of statoliths (gravity sensing organs) in plants will be tested by exposing plants with capped and uncapped roots to spaceflight. The root caps of the flight and control plants will be examined post-flight by electron microscope for statolith changes.

Lloyd Bruce, St. Louis, Mo., "**Effects of Weightlessness on Grain Formation and Strength in Metal**." This experiment will heat a titanium alloy filament to near the melting point and observe the effect that microgravity has on crystal reorganization.

S. Richard Cavoli, Marlboro, N.Y., "**Utilizing a Semi-Permeable Membrane to Direct Crystal Growth in Zero Gravity**." This experiment will attempt to grow fine, rod-shaped lead iodide crystals in zero gravity. Such crystals have application to develop image intensifying screens to be used as detectors of gamma and X-rays.

Steven D. Chang, Tustin, Calif., "**Time Dilations Due to Motion and Gravity**." The purpose of this experiment is to confirm quantitatively the simultaneous effects due to both Einstein's General and Special Relativity theories by comparing atomic clocks—one to be flown on the Shuttle and the other to remain on Earth.

Todd J. Egan, San Jose, Calif., "**Cocoon-Spinning Behavior of Silkworms**." Earthbound experiments have already indicated that silkworms, in spinning their cocoons, employ gravity as an environmental clue. This experiment will observe the effects a zero gravity environment will have on silkworms spinning cocoons in the Space Shuttle.

Andrew I. Fras, Binghamton, N.Y., "**Effects of Weightlessness in Space Flight on the Healing of Bone**." This experiment was designed to study the effects of space on changes on bone growth and repair.

Jeff B. Fuchs, Livonia, Mich., "**Atmosphere Pollutant Location and Concentration Determination Using Spectroscopy**." This experiment is designed to determine the locations and relative concentrations of certain atmospheric pollutants above selected sections of the Earth's surface through the use of spectroscopy—the study of the dispersed light from an object.

Edward W. Gulley, Winston-Salem, N.C., "**Observation of Various Gravity Induced Phenomena of Oat Coleoptiles in a Zero Gravity Environment**." Corn and oat coleoptiles will be positioned in space, with half oriented perpendicular to the others. They will be preserved in space with a fixative and examined post-flight for changes in callose formation and the distribution pattern of calcium ions and amyloplasts.

Douglas D. Hensley, Parkville, Mo., "**Effects of Deuterium Oxide on Plant Growth in a Zero-Gravity Environment**." The objective of this experiment is to explain the mechanism involved in the inhibitary effect of heavy water on deuterium oxide ($2H_2O$) on plant growth. It will determine if growth inhibition is due to impaired RNA synthesis on retardation of osmosis due to the greater mass of the $2H_2O$.

William D. Loftis, Jr., Scott Depot, W. Va., "**Monitoring the Effects of Simulated Gravity on Plants**." The object of this experiment is to see whether centrifugal force, as a gravity substitute, affects the generation and growth of bean and mustard plants at the

1g, ½g simulated gravity levels and at the zero gravity level.

Timothy D. Maclay, Springfield, Pa., "**Quantitative Confirmation of Einstein's Theories of General and Special Relativity**." The purpose of this experiment is to confirm quantitatively the simultaneous effects due to both Einstein's General and Special Relativity theories by comparing atomic clocks—one to be flown on the Shuttle and the other to remain on Earth.

Shawn P. Murphy, Newbury, Ohio, "**Purification and Growth of Single Crystal Gallium by the Float Zone Technique in a Zero Gravity Environment.**" For this experiment a single crystal of Gallium doped with Thallium will be grown in space and compared to a crystal grown in an identical manner on Earth. In the absence of gravity, a more uniform distribution of the Thallium and a more perfect Gallium crystal should result.

Tracy L. Peters, Walnut Creek, Calif., "**Zero Gravity Growth of Ice Crystals from Supercooled Water with Relation to Temperature**." This experiment will observe the formation of ice crystals at various supercooled temperatures below zero degrees centigrade in a gravity free environment. Absence of gravity will allow for a better understanding of the relationship between temperature and crystal geometry by eliminating faults.

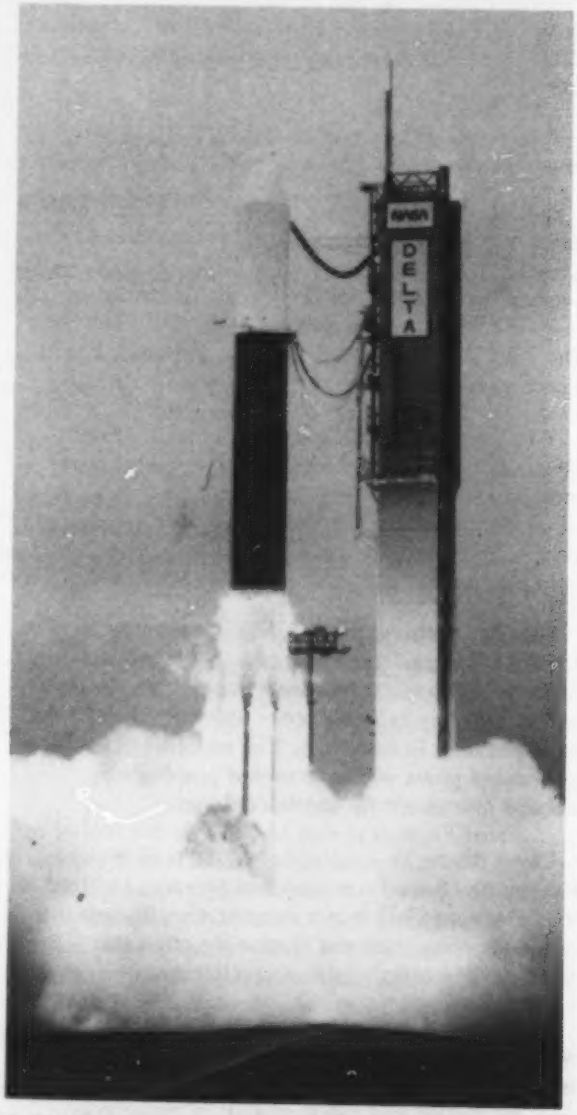
Gregory S. Peterson, Brigham City, Utah, "**Investigation of Arc and Ion Behavior in Microgravity**." This experiment is designed to study arc behavior in microgravity. The diffusion and turbulent mixing of gaseous ions, and the determination of minimum energy paths for successive arc discharges will be determined by use of the arc source called a Jacob's ladder.

Dan M. Poskevich, Waverly, Tenn., "**Comparison of Honeycomb Structures Built by Apis Millefera**." A premature colony of bees will be flown aboard the Shuttle to examine the effect of weightlessness on honeycomb construction.

Scott M. Tyner, LaGrangeville, N.Y., "**Effects of Heat, Light, and Zero Gravity on the Tunneling Habits of Earthworms**." This experiment will examine the tunneling habits of 10 earthworms flown aboard the Shuttle with the behavior of 10 worms in a control experiment on Earth.

Chia-Lien Wang, Waco, Texas, "**Measurement of Auxin Levels and Starch Grains in Plant Roots**." Bean plants will be grown and then frozen in space. The plant roots will be analyzed post-flight for auxin location and concentration and correlation with statholith location and the cells.

Timothy R. Young, Madison, Wisc., "**Effects of Microgravity on Red Blood Cell Mass in Horizontally Oriented Species Versus Vertically Oriented Species**." This experiment will investigate the process that stimulates a decrease in red blood cell mass of goldfish in a weightless environment.



NASA's July Launch—Landsat D, on liftoff July 16 from Western Space and Missile Center, Lompoc, Calif. The NASA earth resources applications satellite was carried to orbit by a Delta expendable launch vehicle.

Patents for Inventions from NASA Research

The office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
William E. Miller, Arden Sher and Yuan H. Tsuo, College of William and Mary Williamsburg, Va.	Photocapacitive image converter	4,331,873	LaRC
Tage O. Anderson, Caltech/JPL	Control means for a solid state crossbar switch	4,331,956	NRO/JPL
Jack S. Margolis, Caltech/JPL	Coherently pulsed laser source	4,332,441	NRO/JPL
Judd R. Wilkins and David C. Grana, NASA/LaRC	Apparatus and process for microbial detection and enumeration	4,335,206	LaRC
Robert C. Bill and James S. Sovey, NASA/LeRC	Thermal barrier coating system having improved adhesion	4,335,190	LeRC
Robert C. Bill and Donald W. Wisander, NASA/LeRC	Fully plasma-sprayed compliant backed ceramic turbine seal	4,336,276	LeRC
John C. Evans, Jr., An-ti Chai and Chandra P. Goradia, NASA/LeRC	High voltage V-groove solar cell	4,335,503	LeRC
William A. Brainard and Donald R. Wheeler, NASA/LeRC	Improved refractory coatings and method of producing the same	4,336,117	LeRC

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	March 22	KSC	OSS-1
*Columbia (OV-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-B, Telesat-E

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* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C[1]	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August 19	Delta	ESMC	Canada communications. Reimbursable.
Intelsat V-E	September 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-E	November 18	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-F	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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* Successful launch

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Increased Safety and Comfort

NASA's Ames Research Center, Mountain View, Calif., developed a foam material designed to improve crash protection for airplane passengers. This "memory foam,"* used in padding aircraft seats, not only provides better impact protection but enhances passenger comfort. Body weight and pressure is distributed over the entire contact area, flowing to match the contour of the body pressing against it and returning to its original shape once the pressure is removed. As a shock absorber, a three-inch foam pad can absorb the impact of a 10-foot fall by an adult.

This material has become one of the most widely used spinoffs from NASA technology with seat cushion applications in furniture, transportation vehicles, athletic equipment as well as medical applications such as wheelchair padding, hand padding for burn patients, and mattresses for the bedridden. Shown are two of these applications. At bottom left is an orthopedic seat for those who spend long periods in wheelchairs, office chairs, auto or truck seats. This foam cushion distributes pressure evenly providing a custom fit for the individual back and encouraging spinal disc alignment. In the photo above, this foam spinoff material is used in the cushions of helicopters operated by the Huntington Beach Police Department for greater pilot comfort and less fatigue. Department officials have found the cushioning has enabled an increase in patrol flying time.

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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About the Cover

New Venus Mission?—Artist conception of proposed Venus Mapper operating in various stages of its elliptical orbit. The spacecraft would use imaging radar to penetrate Venus' global cloud cover (as shown at center). The imaging radar system, called Synthetic Aparture Radar would operate once each orbit for approximately 40 minutes from an altitude as low as 250 km (155 miles). This mapping effort would continue for 243 days and would result in detailed radar images of 90 percent of the planet's surface. Venus Mapper is proposed by NASA's Jet Propulsion Laboratory, Pasadena, Calif., as a new mission for the agency's Office of Space Science and Terrestrial Applications.

Below is Pioneer photo of Venus taken within the last two years revealing the planet's heavy cloud cover. Venus' clouds rotate around the planet every four days. Pioneer Venus will remain in orbit until 1986.

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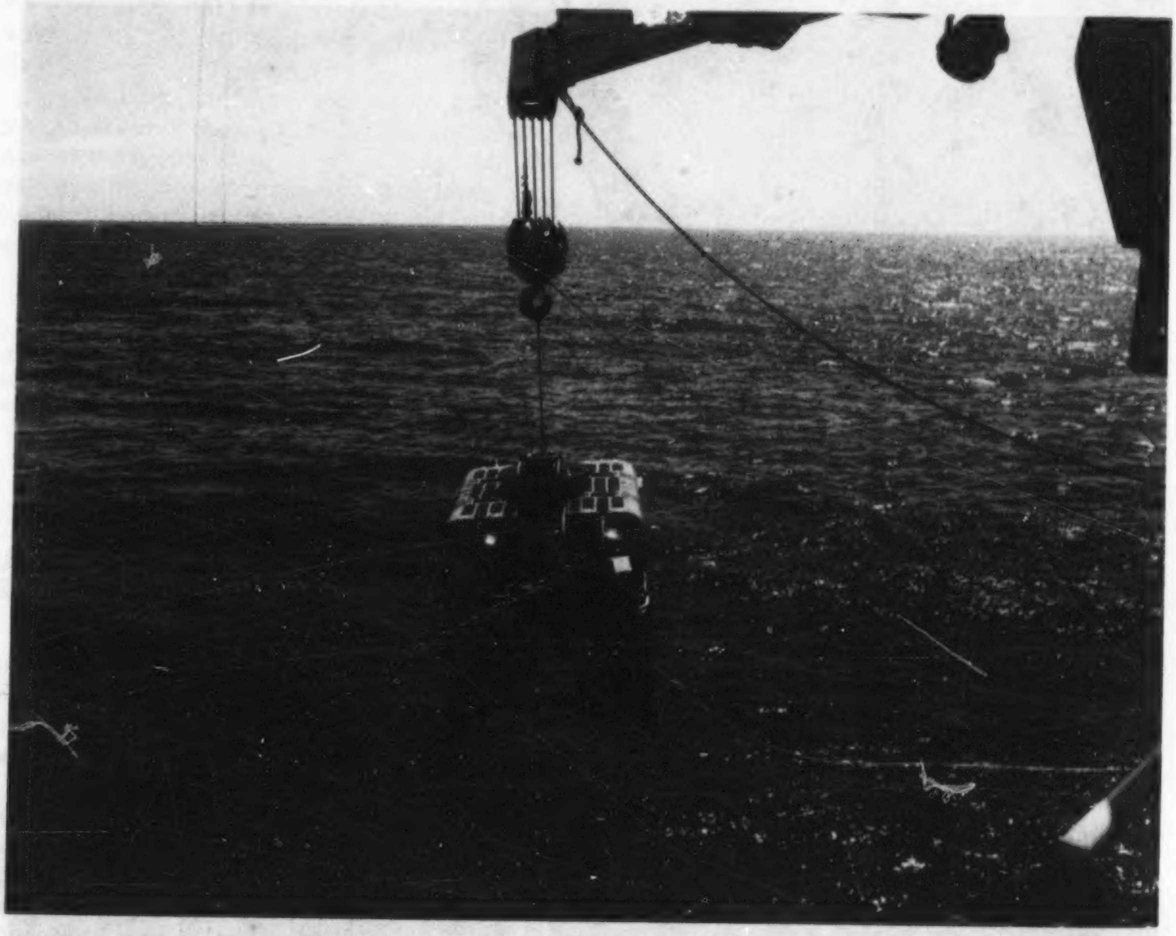
Robot Underwater Investigator Aids NASA

Roughly two minutes after the fourth launch of Space Shuttle Columbia on June 27, the twin solid rocket boosters separated as scheduled from the orbiter and external tank and began their descent toward impact with the Atlantic Ocean, approximately 122 nautical miles (144 statute miles) downrange from the launch site. On this flight, however, a systems failure occurred that caused this hardware to sink to the depths of the ocean floor.

Radar located the boosters at a depth of approximately 3,500 feet—water too deep for humans in hard shell diving suits to inspect. For help in investigating the cause of the flotation failure, NASA turned to a unique "ocean robot" called SCARAB. Engineered and built by Ocean Search, Inc., Lanham, Md., this tethered unmanned vehicle works at any ocean depth up to 6,000 feet, limited only by the ability of the surface ship to maintain station.

SCARAB has power to operate in surface currents up to 3 knots and in underwater currents of up to ½ knot at 6,000 feet. It can function independently of other ship facilities as it is equipped with power generation and semi-automatic handling equipment.

SCARAB comes equipped with two heavy-duty hydraulic manipulators (or robotic arm and hand),



SCARAB, unmanned tethered robotic underwater ocean vehicle used by NASA to extensively photograph the solid rocket boosters lost during the fourth Space Shuttle flight. This ocean robot performs various tasks in ocean depths up to 6,000 feet; the boosters sank in ocean water about 3,500 feet deep. The vehicle is shown being launched from one of the booster recovery ships.

complete optical system, six 5 hp electric thrusters, high resolution sonar, navigation system, and four magnetometers.

Of particlar interest to NASA was SCARAB's camera system. Three television cameras mounted on separate pan/tilt mechanisms allow real-time observation and video tape documentation; one 35-mm still camera also is mounted on a pan/tilt system. Six quartz-iodide flood lights provide illumination in the darkness of the ocean depths.

Tethered from one of the solid rocket booster recovery ships, UTC Freedom or Liberty, SCARAB's initial assignment was to photograph extensively the damaged boosters. Navigational control for SCARAB was handled by a remote station set up on the recovery ship. The operator hut and bridge displays provided complete vehicle status information such as range/bearing, heading, depth and pitch/roll of the vehicle.

SCARAB's documentation was shipped back to NASA's Marshall Space Flight Center, Huntsville, Ala., for analysis by an investigative board set up to determine the cause of the booster deceleration failure. The photographs revealed that the boosters were broken up by the force of the water impact. One was broken into a large number of parts; the other booster has the forward skirt and top solid rocket booster segment intact, a section about 12 meters (40 feet) in length. This section of the booster contains the flight recorder and other electronic equipment that could provide useful information to the investigative board on the cause of the failure.

NASA has decided to raise this part of the booster assembly for inspection. Procedures are being developed to perform the recovery operation. The largest piece of booster debris has no built-in lift points and probably has a large amount of sea water trapped inside.

However once recovery procedures are established, SCARAB will be used for an integral phase of this task. Using its robotic arms, the underwater robot can cut large diameter wire rope and attach large capacity recovery lines to the sunken booster. The vehicle's manipulators are manufactured with adaptable mounting surfaces which allow for custom selection and fitting of tools for a wide variety of ocean work applications. The solid rocket booster recovery ships or salvage ships will perform the hydraulic lifting operation required to raise the hardware from the ocean floor.

Several of SCARAB's photographs of the fourth Shuttle mission sunken solid rocket boosters taken from an ocean depth of about 3,500 feet. At top, a nearly complete solid rocket motor casing and assorted debris are visible. The tubing in the foreground of the photo is on SCARAB. In bottom photo, booster parachutes and parachute lines form a tangled web pattern on the bottom of the ocean floor.

U.S. Participates in International Space Conference

In August NASA Administrator James M. Beggs headed the U.S. delegation to Unispace '82, an international conference created to promote greater global awareness of the state of space technology and its potential benefits to mankind.

Held in Vienna, Austria from August 9-21, the conference focused on international cooperative activity in space, with particular emphasis on how space technology can help promote economic development in the world's poorer countries.

The agenda for Unispace '82 was divided into three broad categories: (1) state of space science and technology; (2) applications of space science and technology; and (3) international cooperation and the role of the United Nations. Within these categories, detailed discussions were held on such global concerns as economic development, education, communications, resource management, environmental protection and the utilization of space technology with respect to these areas.

Unispace '82 (or the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space), drew participants from over 140 countries and international organizations. The first conference of this kind held in 1968 had 78 participants.

The U.S. delegation entered Unispace '82 with a substantial record of international cooperative space effort. Since its inception in 1958, NASA has signed over 1,000 agreements with over 100 countries for cooperative space programs. The agency has worked

NASA

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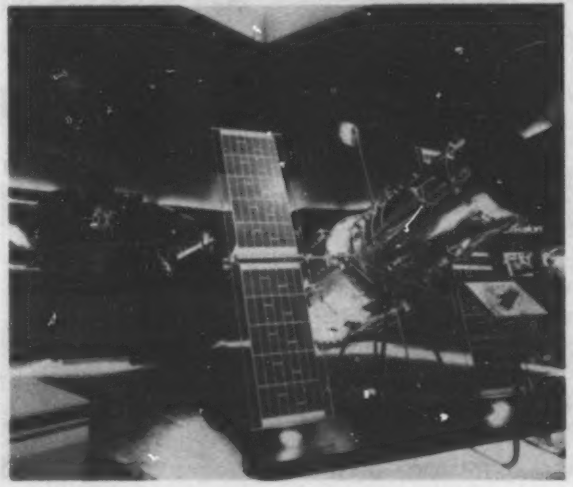
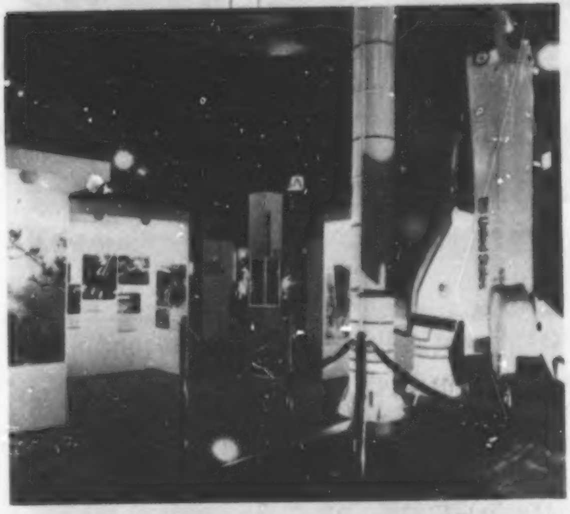


MARTIN MARIETTA



Opposite page and above: Scenes from the U.S. exhibit at Unispace '82, an international conference created to promote greater global awareness of the state of space technology and its potential benefits to mankind, Vienna, Austria, Aug. 9-21.

with the European Space Agency (ESA) on many projects, the largest being Spacelab; and with Canada, France, Germany, Italy, the Netherlands, Spain and the United Kingdom on cooperative spacecraft projects.

In the context of the Landsat project, NASA has helped developing countries apply remote sensing technology for crop prediction, mineral and ground water exploration and resource management and mapping. In addition, the Agency for International Development has established a Rural Satellite Program using small stations and existing satellite systems to provide basic communications services, health care information, agricultural advice and radio and television learning programs to impoverished areas of the world.

One example of the application of space technology to development, was India's SITE (Satellite Instructional Television Experiment) program, August 1975-1976. Using the NASA AT-6 satellite and conventional television sets augumented with special electronics and antennas of chicken wire, the program brought education, farming and health information to a largely illiterate population in 2,400 rural villages. Viewers learned better agricultural methods and hygiene in their many dialects. The programs were beamed from India through the NASA-provided ATS-6 satellite that hovered over Kenya during the year-long experiment.

Similar satellite signals originating from a U.S. ground station had previously been educating children in Appalachia and communicating medical diagnoses in Alaska.

More than 20 countries displayed exhibits at Unispace '82 including the United States, Japan, West Germany, France, Canada, India, and the Soviet Union. The theme of the U.S. exhibit was "Working Together to Benefit Spaceship Earth." It consisted of 12 total exhibit structures; one from NASA at the center surrounded by 11 others from U.S. companies, visually linked to demonstrate U.S. leadership in space as the result of both government and private sector contributions.

The 11 companies participating in the U.S. Unispace exhibit were: Ford Aerospace, General Dynamics, Grumman Aerospace, IBM, International Imaging, Lockheed, Martin Marietta, McDonnell Douglas, RCA, Rockwell International and Townsend Associates.

Over 10,000 people viewed the U.S. exhibit each day.

In addition to providing extensive exhibit materials, the United States participated in several live demonstrations of space technology at the Unispace conference. The Communications Satellite Corporation (COMSAT) provided remote interpretation services for part of the conference proceedings via satellite telecommunications link between Vienna and the United Nations Headquarters in New York City. The National Oceanic and Atmospheric Administration (NOAA) contributed hardware for use in demonstrating meteorological satellites coordinated by the World Meteorological Organization. NASA sponsored two demonstrations: one of low-cost equipment for processing remote sensing data; the other of photovoltaic technology which is being utilized to provide electricity in developing countries.

The first international United Nations space conference was held in Vienna in August 1968 and, like Unispace '82, originated with the United Nations Committee on the Peaceful Uses of Outer Space. The U.S. delegation to the conference, upon which the current Unispace delegation is modeled, was also headed by a NASA Administrator: James Webb.

Since the first world space conference, enormous achievements in space science and technology have taken place:

- landing of men and robot vehicles on the Moon;
- automated landers on Mars and Venus;
- missions past Jupiter and Saturn;
- manned Skylab missions;
- Space Shuttle—world's first reusable spacecraft now a fully operational Space Transportation System;
- routine operation of space communications satellite systems which provide international meteorological, navigational and maritime communications as well as remote sensing data.

Since the first world space conference in 1968, more and more countries now enjoy the benefits of the practical applications of space technology:

- Indonesia connects its thousands of islands together through a national communications satellite system;
- India is building its own satellites and launch vehicles and is establishing a multipurpose communications and meteorological satellite system;
- Five developing countries—Argentina, Brazil, India, Indonesia and Thailand—have established Landsat data acquisition and processing facilities.

And international participation in space-activity related organizations has dramatically increased:

- membership of the United Nations Outer Space Committee has grown from 28 members in 1968 to 51 today;
- INTELSAT from 68 members in 1968 to 105 today;
- International Maritime Satellite Organization, established Feb. 1982, already has over 30 members;
- European Space Agency (ESA), grew to its present form of 11 member nations: Germany, Belgium, Denmark, Spain, France, United Kingdom, Italy, Ireland, the Netherlands, Sweden and Switzerland. Norway, Canada and Austria are observers.

The heavy international interest and participation in Unispace '82, almost doubled from the first conference 14 years ago, illustrates that the nations of the world are realizing that space technology can help to improve the quality of life here on Earth. One of the purposes of Unispace is to further this goal.

Oshkosh: Salute to NASA Aeronautics

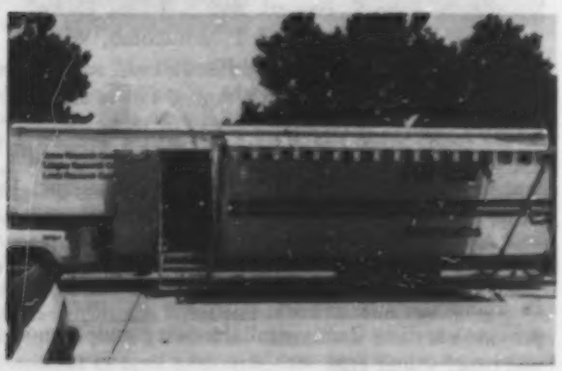
"Salute to NASA Aeronautics" was the theme of the 1982 Experimental Aircraft Association National Convention held in Oshkosh, Wisconsin, July 31 to Aug. 7. Highlighted at the world's largest annual aviation convention was NASA's research and advanced technology developments in civil, military and general aviation.

NASA provided one of the convention's largest exhibits housed in a tent structure called the NASA Central Pavilion. Under the canvas were high technology displays and audio visual presentations focusing on agency research and development programs such as vertical and short take-off and landing aircraft (V/STOL), aircraft safety, advanced turbo-prop installation and HiMAT (Highly Maneuverable Aircraft Technology).

An estimated 600,000 people visited the NASA Pavilion during the convention's eight days.

Also present was NASA's newest traveling exhibit unit, AEROVAN, a walk-through trailer housing nine non-technical exhibits which focus on current

CENTRAL NASA PAVILION



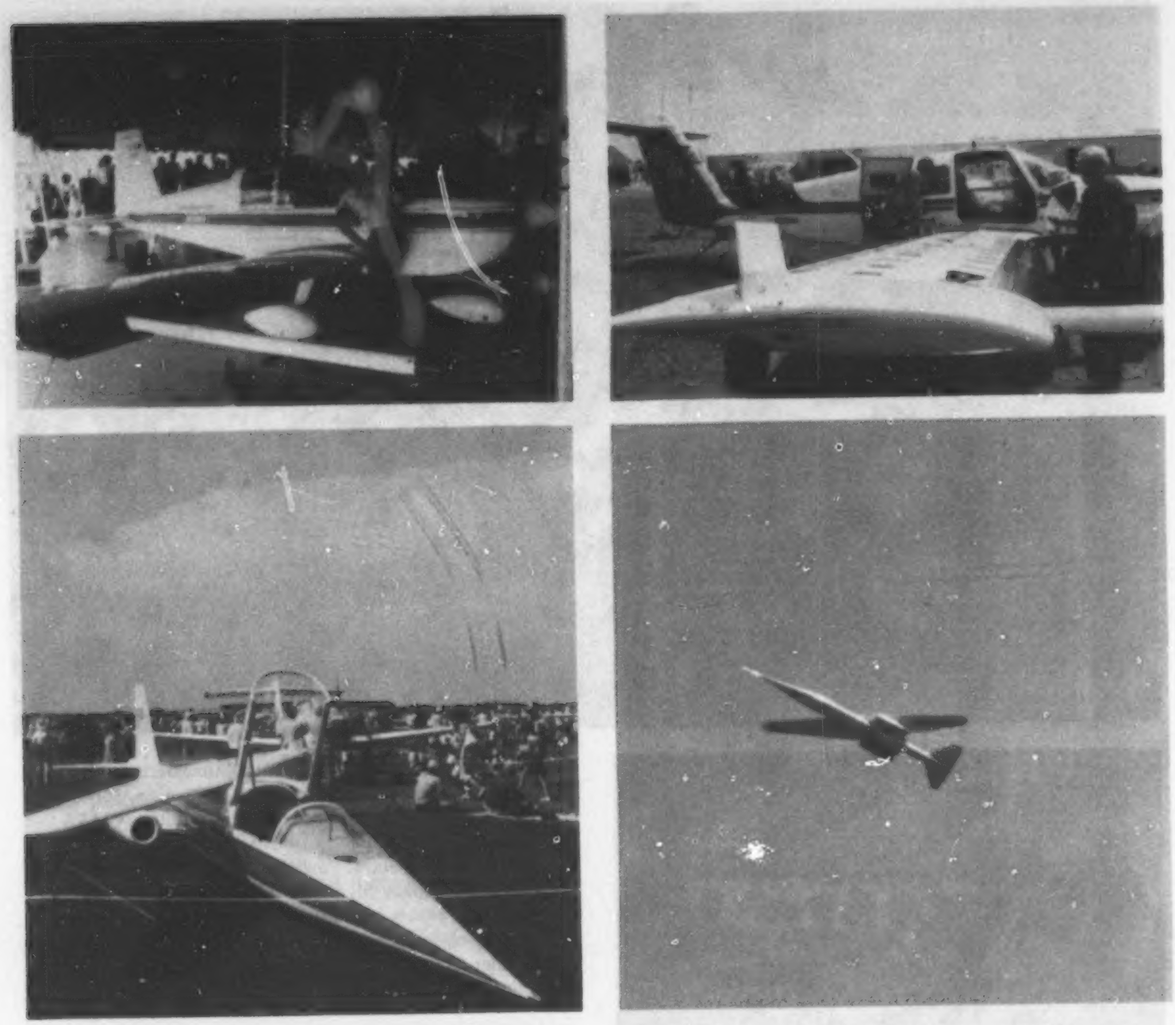
Scenes from the 1982 Experimental Aircraft Association National Convention held in Oshkosh, Wisconsin, July 31-Aug. 7. Theme of the convention was a "Salute to NASA Aeronautics." Top frame is of NASA's main exhibit area called the NASA Central Pavilion. At center left, NASA Administrator James M. Beggs studies one of the pavilion's many exhibit panels and displays. At bottom left, NASA's newest traveling exhibit, AEROVAN, on hand at Oshkosh. The trailer houses nine non-technical exhibits on current aeronautic research.

aeronautical research in safety, energy efficiency, environmental compatability, and improvements in passenger comfort and convenience.

One of the NASA aircraft on display was the AD-1 oblique-wing aircraft, sometimes called the scissors wing. This aircraft flies at low speeds with its wings in the conventional position; at high speeds the wings pivot to an oblique angle of up to 60 degrees which reduces drag and increases speed and range without an increase in fuel consumption.

Other aircraft on display at the Oshkosh convention were two of NASA's general aviation spin research aircraft (NASA 501 and NASA 519).

NASA Administrator James M. Beggs, and



Photos at top are of two of NASA's general aviation spin research aircraft sent to the convention from NASA's Langley Research Center, Hampton, Va. Bottom frames show the the NASA AD-1 oblique-wing aircraft also on hand at Oshkosh. At bottom right, this aircraft gives a flight demonstration of its unusual wing pivot feature.

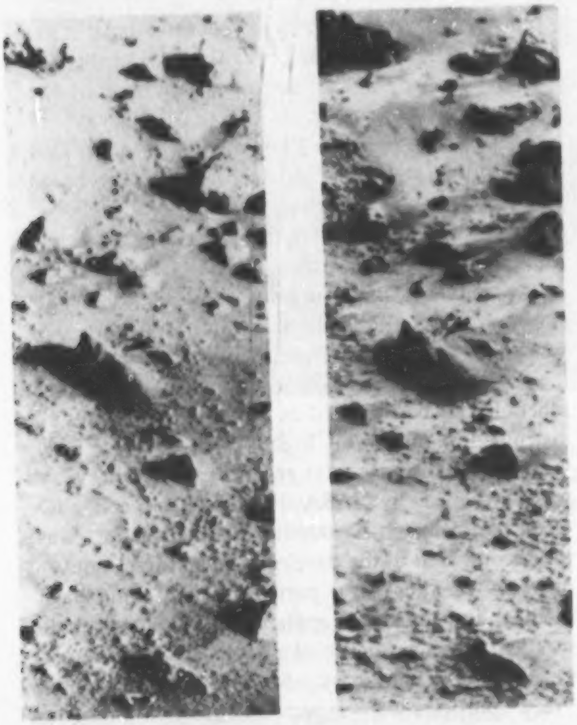
Associate Administrator for Aeronautics and Space Technology, Dr. Jack L. Kerrebrock, participated in convention activities along with NASA aeronautics center directors Dr. Donald P. Hearth of Langley Research Center, Hampton, Va.; Andrew J. Stofan of Lewis Research Center, Cleveland; and C.A. Syvertson of Ames Research Center, Mountain View, Calif.

Ten scientists from NASA's three major aeronautics centers were honored for distinguished aeronautical research at the convention. From Ames, honorees were: Seth B. Anderson, Robert D. Reed, Murray Tobak, and R. T. Jones; from Lewis, Abe Silverstein, John S. Evvard, and J. Irving Pinkel; and from Langley, Richard T. Whitcomb, W. Hewitt Phillips, and John P. Reeder.

Researchers from NASA's Ames, Lewis and Langley centers presented a series of technical papers at convention forums. A NASA information tent was staffed by public information personnel to assist convention attendees and participants with materials on NASA programs. Various publications and visual materials were available for distribution. In addition, three NASA aerospace lecturers provided lecture demonstrations using slides, models and other visual aids.

For the eight days of the convention, Wittman field at Oshkosh became the world's busiest airport, nearly four times busier than Chicago's O'Hare Field by comparison. Over 10,000 aircraft swelled the usually quiet Oshkosh airport for this event.

The convention used 877,187 square feet of indoor and outdoor exhibition space; 350 representatives from aircraft manufacturers, retail and wholesale parts and aviation services attended; and over 200 educational forums and workshops were produced by the Experimental Aircraft Association during the convention.



Images from Mars—Two photos of the Martian surface taken by the Thomas A. Mutch Memorial Station (Viking Lander 1) in the Chryse Basin in the northern hemisphere of Mars show a 5-cm (2-in) pile of soil placed beside and partly atop an 11-cm (4-in) rock by the lander's soil-sampling arm in July 1977. The left photo was taken Feb. 1979; the right photo in July 1981. Comparison shows that some of the soil has been removed by the Martian wind to re-expose the rock, illustrating that as on Earth, deposition and removal of fine material is a continuing cycle on Mars. This pile formation, called Conical Pile # 4, is one of five placed around the lander to measure the amount of material stripped away with time. NASA's Jet Propulsion Laboratory, Pasadena, Calif., manages the Viking project.

NASA-Sponsored Development Opportunities

NASA supplements employee development efforts by sponsoring a number of internal and external fellowship, work experience, and training programs for selected employees whose performance has demonstrated management ability. The annual cycle for selection is under way. Your local training office has program information, nomination procedures, and local suspense dates. The table below lists those programs which are available:

Title	Length	Nomination due in Hq
Fellowships		
Legis Fellows	6 mos.	10-1-82
MIT-Sloan	1 yr.	10-1-82
MIT Advanced Study	13 wks.	10-1-82
Stanford-Sloan	9 mos.	10-1-82
Education for Public Management	2 semesters	10-1-82
Hugh L. Dryden Memorial	10 mos.	10-1-82
Carnegie-Mellon Public Education	3 wks.	10-1-82
Harvard Senior Managers	3 wks.	10-1-82
Harvard Advanced Management	13 wks.	10-1-82
Harvard Program for Senior Executives	13 wks.	10-1-82
Harvard Program for Management Development	14 wks.	10-1-82
Syracuse Maxwell Midcareer	15 wks.	10-1-82
Simmons Middle Management	10 wks.	10-1-82
Congressional	10 mos.	10-1-82
Industrial College of the Armed Forces	11 mos.	10-1-82
Work Experience Programs		
Executive Development Work Experience	optional	2-15-83
SES Candidate Development	12-18 mos.	2-15-83
Career Development Program	1 yr.	2-15-83
Critical Assignment Development Program	optional	2-15-83
President's Executive Exchange	1 yr.	2-15-83
Management Education Center Wallops Island, Va.		
Executive Seminars	9 days	2-15-83
Management Education Program (MEP)	2 wks.	2-15-83
MEP Follow-On Seminars	1 wk.	2-15-83
Project Management Shared Experience	5 days	2-15-83

Fourth Shuttle Mission Experiment Data Analyzed

Investigators at NASA's Marshall Space Flight Center, Huntsville, Ala., are examining preliminary data for several experiments flown aboard the fourth flight of Space Shuttle Columbia in June: the continuous flow electrophoresis system experiment, induced environment contamination monitor, and monodisperse latex reactor.

The continuous flow electrophoresis system experiment, the nation's first commercial payload to fly aboard the Shuttle, "performed almost flawlessly" during the last mission according to Richard Brown, commercial applications manager in Marshall's Materials Processing in Space projects office. The system, designed and funded by the McDonnell Douglas Astronautics Corp., to separate biological materials according to their surface electrical charge, successfully separated six protein samples. The samples included a mixture of egg albumen and rat albumen to demonstrate the device's separation capability at an increased output in space, and a cell culture fluid which contained many types of proteins to test the capability to separate a large number of natural substances at the same time.

The experiment was flown on the Shuttle under terms of the first joint endeavor agreement through which NASA and industry share in the cost, risk and benefits of the endeavor. The agreement is managed by Marshall.

The samples separated during the fourth mission traveled through the electrophoresis column as expected, reported McDonnell Douglas spokesman Ray Deffrey. The electrophoresis experiment is scheduled to fly again on the sixth Shuttle flight in January 1983.

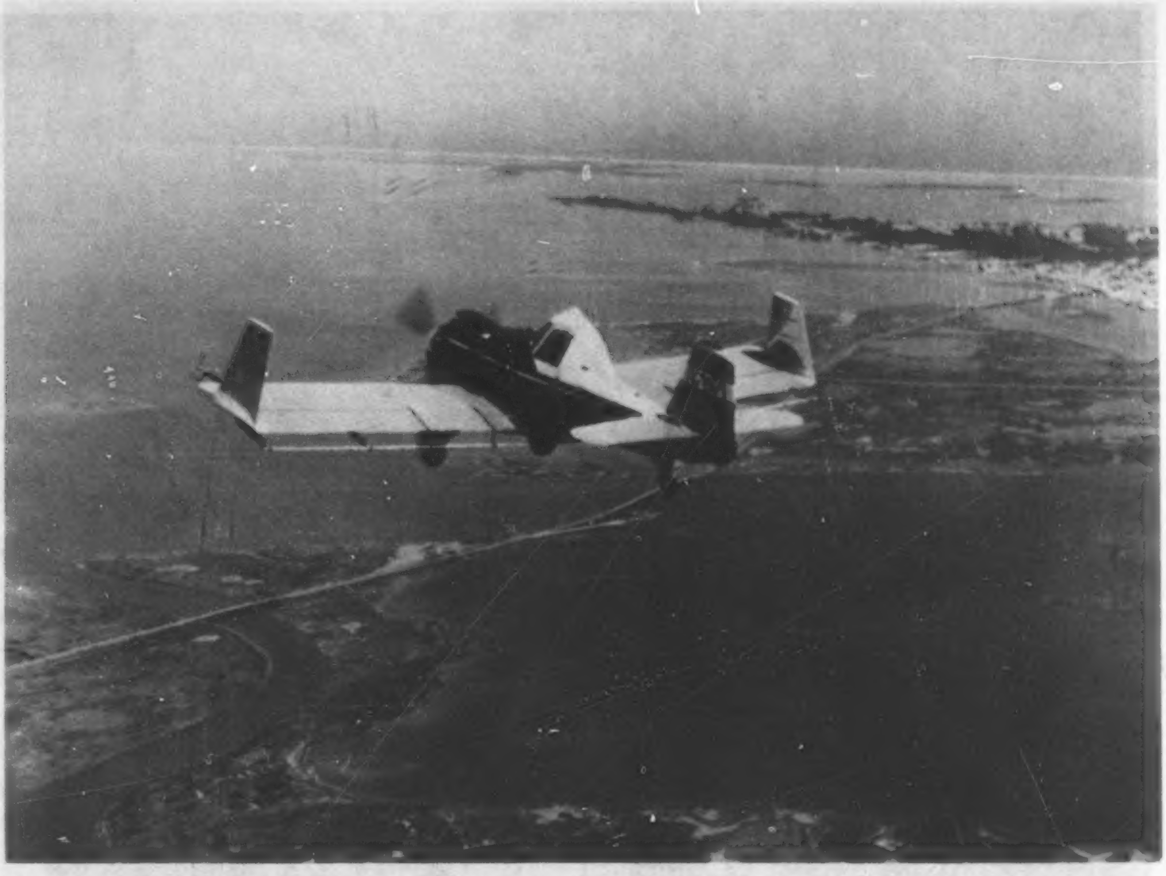
On Earth, gravitational effects limit the concentration of biological materials in the sample being processed to one-quarter of one percent and limits the sample stream size to one-half millimeter in diameter. During the mission, a sample of 25 percent concentration appears to have been processed in the experiment using a sample stream size of one millimeter. "The experiment demonstrated that the increased concentration, coupled with the increased sample stream size, could give 400 times more output than an Earth-based electrophoresis," said Walter Wood, Marshall manager of the joint endeavor agreement. "The objective was to achieve this output without degradation in purity," Wood said. Laboratory analysis of the separated samples is underway at McDonnell Douglas in St. Louis, Mo.

Marshall's induced environment contamination monitor flown for the third time aboard Space Shuttle Columbia, performed to specifications except for an anomaly during the plume pressure test. The monitor's operation was successful in completing a mapping of contaminants in and around the orbiter cargo bay when it was lifted up by Canada's remote manipulator system and placed at 25 locations. The monitor also completed another test which measured the interaction of a known gas released by the monitor with atmospheric gases at orbital velocity.

During a second exercise on the manipulator arm, the monitor was positioned over the nose of the orbiter to gauge the pressure wave generated by the firing of the reaction control jets, using a newly installed plume pressure gauge on the monitor. Due to unknown causes, the signal to activate the gauge apparently was not received by the monitor, according to Edgar Miller, project scientist in Marshall's Space Sciences Laboratory. The cause of this failure is under investigation. The induced environment contamination monitor is next scheduled to be flown aboard the Spacelab 1 mission in October 1983. The plume pressure gauge is not scheduled to be included as part of the monitor's instrumentation on this flight.

The monodisperse latex reactor experiment, which was developed by NASA's Marshall Space Flight Center and Lehigh University, Bethlehem, Pa., was the second step in the development of large monodisperse (identical size) particles which could have medical and industrial applications. The experiment was first flown on the third Shuttle flight in March. On the fourth Shuttle mission, four batches of latex "seed" particles were expected to grow in a range of sizes up to 10 microns. An early post-flight report stated "a malfunction of unknown origin occurred during the mission preventing the chemical process from taking place as planned."

However Marshall scientists have discovered that sufficient heating did occur in the experiment reactors, when coupled with the flight's seven-day duration in the zero-gravity environment of space, to allow the chemical process to be at least 55 percent completed. During the mission, the chemical reaction passed the critical stage which must be done



Agricultural Benefits—NASA research aircraft in flight over Virginia's Eastern Shore during performance testing on wing tip modifications designed to improve efficiency in application of agricultural sprays. Winglets, or vertical wings at the tip of a main wing, are used in this modified Ayres Thrush 800 to better control the movement of air that swirls off the end of the wings. Moderation of this movement can improve the spray pattern and reduce drift of agricultural materials out of the target area. The program is managed by NASA's Langley Research Center, Hampton, Va.

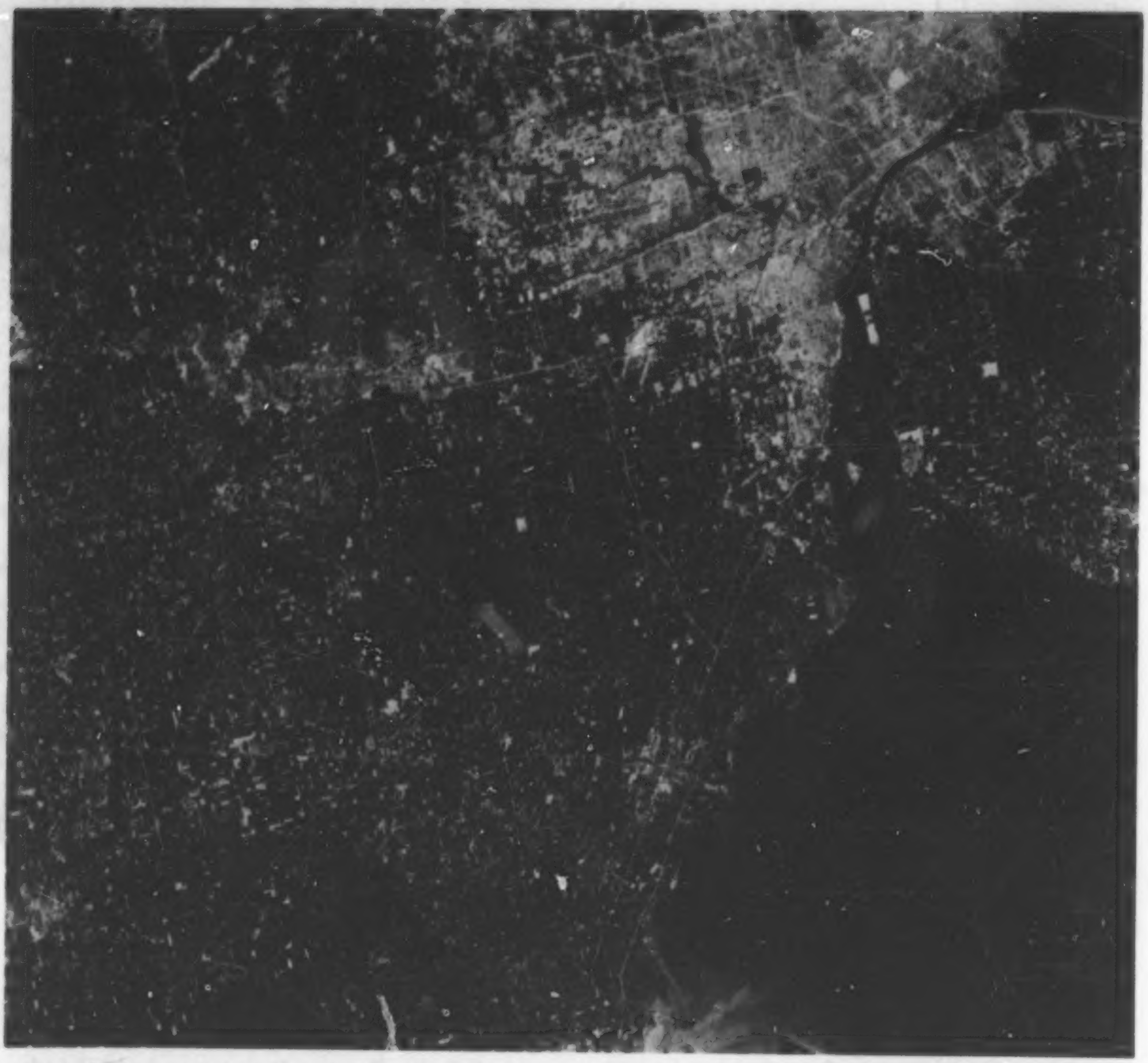
in weightlessness in order for the particles to be formed properly. Scientists at Lehigh University were able to finish the latex-forming chemical process on the ground. Principal investigator Dr. John W. Vanderhoof estimated the final particle size to have reached 7.9, 9.4, 10.3, and 10.8 microns, about 1½ to 2 times their original size. The monodisperse latex reactor is scheduled to fly aboard the next Shuttle mission in November.

Landsat 4 Returns First Images

Landsat 4 (formerly Landsat D), successfully launched July 16 from Vandenberg Air Force Base, Calif., is presently in excellent condition in its 694-kilometer (481-mile) orbit. Two of the spacecraft's highly sophisticated sensors—the multispectral scanner and thematic mapper—were activated and the first images taken by these instruments have been processed through the ground data system at NASA's Goddard Space Flight Center, Greenbelt, Md.

The multispectral scanner, flown on Landsats 1, 2, and 3, is a radiometer—an instrument that collects and measures solar energy reflected or emitted in discrete intervals of the green, red, and near infrared parts of the electromagnetic spectrum.

The multispectral scanner is used to delineate the extent and condition of a wide variety of vege-



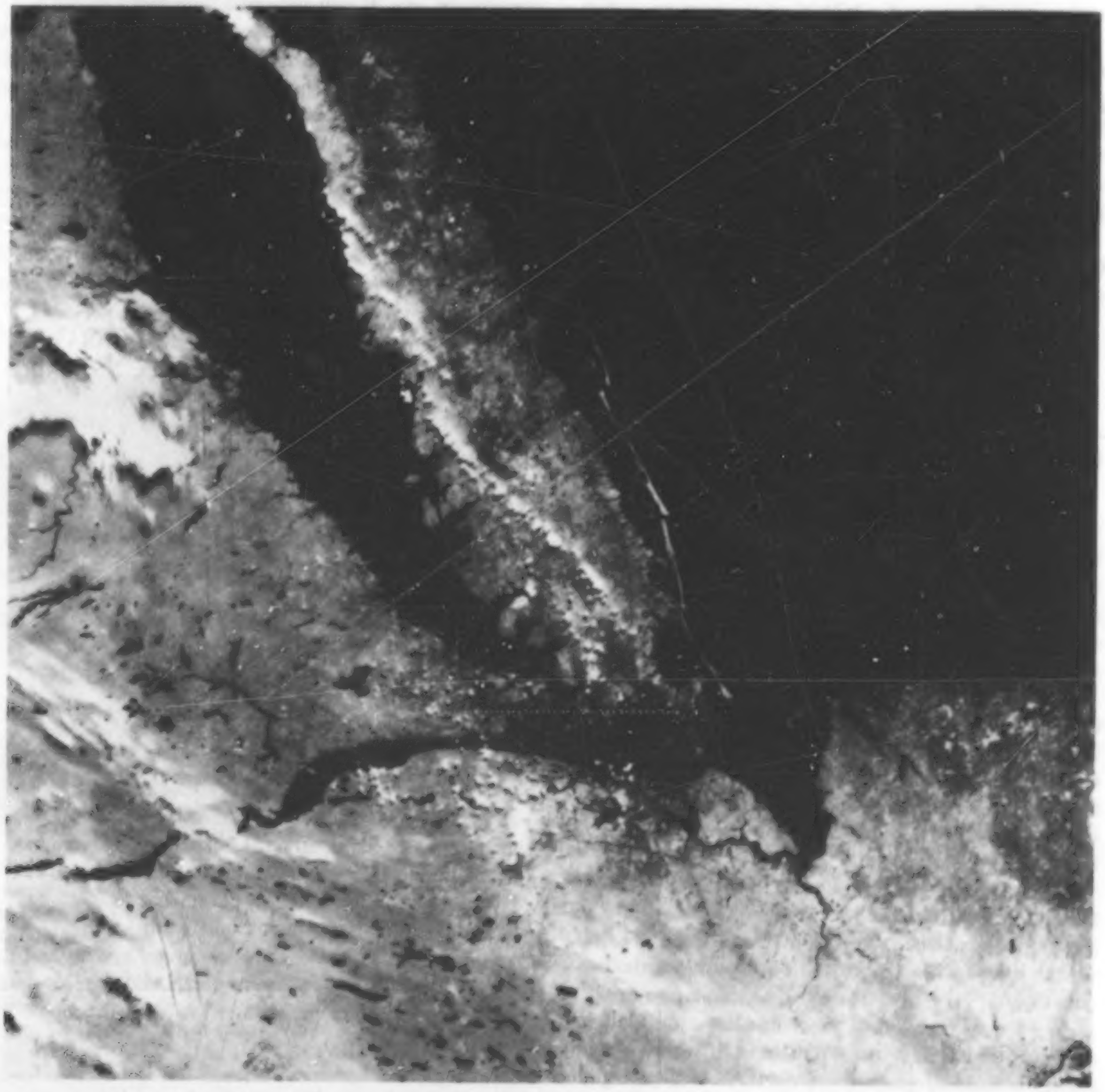
First image from Landsat-4's thematic mapper taken July 20. The resultant 185 × 185 km (115 × 115 mile) image is a composite of three individual images from detectors in the green, red, and infrared portions of the spectrum. In this quadrant section enlargement of the image, nearly all of Detroit, Michigan, and the northern parts of Toledo, Ohio, are visible in the top and bottom portions of the picture, respectively. The large body of water in the lower right is Lake Erie and in the upper right is Lake St. Clair. In the lower (southern) outskirts of Detroit, near the center of the picture, the Detroit Metropolitan Wayne County Airport is visible and to its immediate left (west) is the Willow Run Airport. Landsat-4's thematic mapper was designed to be able to identify areas as small as 30 meters; preliminary examinations point to an image resolution and quality beyond expectations.

tation types, bare soil and rock conditions, and snow cover and water bodies over large areas on a highly repetitive basis. Data from the scanner has been used extensively over the past decade for agriculture, forestry range, water and land cover applications; for determining biophysical characteristics useful in crop yield modeling and for searching for new deposits of oil and mineral resources.

Landsat 4's multispectral scanner was activated on July 19 over New York City; the instrument has an approximate spatial resolution of 1 acre (80 × 80 meters).

The spacecraft's thematic mapper is a new instrument expected to advance the remote sensing capabilities of Earth resources satellites. Thematic mapper provides data in seven spectral (light) bands with improved spectral, spatial, and radiometric resolution. The advantages offered by thematic mapper are in its multispectral observations. The mapper uses significantly narrower bands in the green, red and near infrared compared to the multispectral scanner which allow for increased reflectance and more precise measurement of vegetation on the green and near infrared bands; better distinction of chlorophyll absorption in the red band; and less chance of atmospheric water vapor obscuring land surface imaging in the near infrared.

With the thematic mapper's new band measuring reflected sunlight in the blue-green portion of the spectrum, natural color images of the Earth's surface



First multispectral scanner image from NASA's Landsat 4 spacecraft. Activated July 19 over New York City, the resultant 185 × 185 km (115 × 115 mile) image is a false color composite of three individual images from detectors in the green, red and infrared portions of the spectrum. The Verrazano Narrows Bridge is clearly visible across the New York Bay because of its high contrast with the water.

features are now possible for the first time on a Landsat spacecraft.

Thematic mapper was activated July 20 and its first image taken was of the Detroit, Michigan area. The spatial resolution of thematic mapper will be approximately ½ that of the multispectral scanner, or about 30 × 30 m (98 × 98 ft.). This allows for much smaller features on the surface to be identified and measured.

Data from Landsat 4's multispectral scanner and thematic mapper are presently being returned to ground stations using the direct access X-band and S-band communications systems. The spacecraft has a Ku-band data transmission system which will be used for data transmission when the Tracking and Data Relay Satellite is put into service early next year.

The Landsat 4 program is managed for NASA's Office of Space Science and Applications by the Goddard Space Flight Center, Greenbelt, Md.

Contractor News

NASA has selected eight companies for final negotiations leading to firm fixed-price contracts of less than $1 million apiece for space station mission studies. The studies will contribute to the development of specific mission requirements and overall architectural options for a Shuttle-tended, permanent orbiting facility that could be launched by 1990. The eight companies selected are: **Boeing Aerospace Co.,** Seattle; **General Dynamics, Convair Div.,** San Diego; **Grumman Aerospace Corp.,** Bethpage, N.Y.; **Lockheed Missiles and Space Co., Inc.,** Sunnyvale, Calif.; **Martin Marietta Aerospace, Denver Aerospace,** Denver; **McDonnell Douglas Astronautics Co.,** Huntington Beach, Calif.; **Rockwell International, Space Operations/Integration and Satellite Systems Div.,** Downey, Calif.; and **TRW, Inc., Defense and Space Systems Group,** Redondo Beach, Calif. These studies are part of a space station planning activity underway at NASA to develop a space station program for consideration by the Administration and Congress as the next major initiative in space. The studies conducted under these contracts will be eight months in length and are expected to identify and analyze the scientific, commercial, national security and space operational missions that could be most efficiently conducted by a space station. From this analysis, the contractors will develop alternative concepts for a station.

NASA Administrator James Beggs has announced that NASA will employ a **Space Shuttle processing contractor** at Kennedy Space Center, Fla., to handle preparations, launch, landing and turnaround activities for the Space Shuttle. The contract should result in significant cost savings during the Shuttle operational era. It will minimize interfaces at the launch and landing site and focus clear responsibility on a single contractor to improve flight safety and mission effectiveness. The change to a single Shuttle processing contractor will consolidate not only the contracts for flight hardware processing at Kennedy, but will also include the operation of ground support equipment and related support to fulfill Space Shuttle processing responsibilities. NASA expects to release a formal request for proposals by late November of this year with a contract award targeted for 1983.

Lockheed Engineering and Management Services Co., Inc., Houston, has been selected by NASA's National Space Technology Laboratories, NSTL Station, Miss., for negotiation leading to award of a new contract to provide technical services for its Earth Resources Laboratory. The initial award will approximate $6,456,000 for a two-year period and began Aug. 1, 1982. The contract contains options for an additional three years. NSTL's Earth Resources Laboratory develops applications of remote sensing data taken by Landsat's multispectral scanner and thematic mapper instruments. Laboratory investigators develop techniques for space applied data and other types of data to provide a comprehensive descriptive analysis of change on the Earth's surface in soil type, topographic relief, rainfall and population distribution. Data from the laboratory has been used in determining crop production, erosion factors, and reforestry needs because of erosion. Under terms of the contract, Lockheed will operate and maintain remote sensors in the Earth Resources Laboratory aircraft used for parametric studies where data is collected at ground truth level; operate and maintain the Lab's computer system and develop software to support research and development activities; and operate and maintain the Lab's special purpose photo lab.

Westinghouse Electric Corp., Advanced Energy Systems Div., Large, Pa., has been awarded a contract to develop technology for multimegawatt fuel-cell power plants. The contract, estimated at $37 million to be funded in increments over a four-year period, was awarded under the Department of Energy's Phosphoric Acid Fuel Cell Systems Program managed by NASA's Lewis Research Center, Cleveland. The first phase of the contract, covering a 12-month period, will cost $5.4 million and will define the requirements for a fuel cell power plant. Subscale tests of cells and cell stack assemblies also will be initiated. The industrial goal is to have two 7.5 megawatt fuel cell power plants installed at sites before the end of this decade. **Energy Research Corp.,** Danbury, Conn., is the major subcontractor, a pioneer company in gas-cooled fuel cell technology.

Computer Sciences Corp., Falls Church, Va., has been selected by NASA's Kennedy Space Center, Fla., for final negotiations leading to award of a $9,372,000 firm, fixed-price contract for a Space Shuttle Inventory Management Systems (SIMS) II. SIMS II will assist NASA in ensuring that spare parts, supplies and materials are available as needed to support the Shuttle program. The contract will call for delivery of automatic data processing equipment; communications equipment; computer software; data requirements; training for terminal users, computer operators and system controllers; and software creation and maintenance personnel.

Captured Northern Lights—Usually "northern lights" or auroras can only be seen as a local glimmer in the night sky. Two NASA satellites, called Dynamics Explorers, are returning pictures of auoras as they investigate relationships between the Sun and the Earth. Photographed high over the North pole, the lights can be seen in true size perspective, circling the pole and brightening North America as far south as the Great Lakes. Working in tandem, the two satellites are measuring bursts of solar energy and observing effects on our planet. These bursts are of interest because they can severely disrupt radio communications and power lines, as well as influence climate and weather in as yet little understood ways. The Dynamics Explorer project is managed by NASA's Goddard Space Flight Center, Greenbelt, Md.

Pan American World Airways, Inc., Aerospace Services Div., Cocoa Beach, Fla., has been awarded a follow-on contract by NASA's Johnson Space Center, Houston, to provide plant maintenance and operations at the center. The $12 million cost-plus-award-fee contract runs from Aug. 1, 1982 to July 31, 1983 and covers operation of all Johnson's utility systems and maintenance of utilities, buildings, roads and special equipment at the center. This follow-on award is the second year of a five-year program.

NASA's John F. Kennedy Space Center, Fla., has awarded a **joint venture contract** to **KAMAG Transporttechnik GmbH and Co.,** Ulm/Donau, West Germany and **Precision Fabricating and Cleaning Inc.,** Sharpes, Fla., to provide transporter units for Space Shuttle launch preparations. The contract has a basic value of $2,883,548 and is for the construction, testing and delivery of two self-propelled transporter systems in support of Space Shuttle operations at Kennedy and at Vandenberg Air Force Base, Calif. An option for a third such transporter may also be exercised. If the optional transporter is purchased, the total value of the contract will become $4,203,409. The fixed price contract began June 30, 1982 and will be completed Jan. 30, 1984.

ILC Industries, Inc., Space Systems Division, Houston, has signed a cost-plus-fixed-fee contract with NASA's Johnson Space Center to provide Shuttle crew equipment and training devices for spacewalks and in-cabin activities and Orbiter onboard stowage provisions for the equipment. The 9-month $4,638,000 contract began Mar. 31, 1982 and expires Dec. 31, 1982.

Fulton Shipyard, Inc., Antioch, Calif., has been awarded a $1.8 million dollar fixed-price contract by NASA's Kennedy Space Center, Fla., to provide moving bridge cranes that will be used in a new building to be built at the Space Center for processing solid rocket booster segments. Under terms of the contract, Fulton Shipyard will design, fabricate, install and test two 200-ton traveling electric cranes in the Solid Rocket Booster Rotation/Processing Facility. The contract calls for the work to be done

within the June 1, 1982 to Aug. 1, 1983 timeframe. The cranes will be used for lifting and rotating the heavy solid rocket motor segments arriving at Kennedy for pre-flight inspection, assembly and checkout.

Did You Know?

The **Space Shuttle** is a **featured attraction** at the NASA exhibit during the **1982 World's Fair** in Knoxville, Tenn., May 1 to Oct. 31. July was "Shuttle Month" at the fair and to help commemorate this event, Fair goers were treated to a very special hello from Space Shuttle astronauts T. K. Mattingly and Henry Hartsfield as they encircled the Earth during the fourth Shuttle flight. On July 1, the astronauts radioed a greeting to the World's Fair live from Columbia, encouraging everyone to see the NASA exhibit and speaking briefly of the achievements of the U.S. space program. NASA's 4,000-square-foot exhibit, on display in the Technology and Life Style Pavilion , focuses on "future uses and the role of the Space Shuttle." The exhibit includes two large Shuttle models, each between 15 and 20 feet long. One model depicts the Shuttle on the launch pad, while the smaller models illustrate the Shuttle in operational phases. An estimated 700,000 people visited the NASA exhibit during "Shuttle Month."

Listening to astronauts live from space was a new service recently offered by NASA and AT&T Long Lines. For a fee, anyone in the United States could dial 900/410-6272 and listen in on live commentary between fourth Space Shuttle astronauts T. K. Mattingly and Henry Hartsfield and NASA's Mission Control, Houston. Also broadcast on this line were Shuttle mission status reports and Flight Director briefings at Houston. Response to this "space" number was tremendous: 1,026,000 calls, averaging three minutes apiece, were placed during the 7-day mission. This telephone service was first offered during the second Space Shuttle mission last November, restricted to U.S. media. In March, for the third mission, the service was expanded to include overseas media. In response to heavy public request, NASA and AT&T opened the number in June to accommodate public calls. NASA hopes to offer this same service for the fifth flight in November.

NASA was awarded four Blue Pencil Publications Awards by the National Association of Government Communicators for outstanding government publications produced in 1981. **"A Free People Capable of Great Deeds"—the Story of STS-1,** received **second place** in the category "folders, brochures, leaflets, 16 pages or fewer." The mission report was written by Victor Seigel of the publications section at Headquarters. An **honorable mention** in the category "other serials for general or technical audience" was awarded to **Spinoff 1981,** designed by Beveridge & Associates, Inc., for Robert Schulman, graphics coordinator, Headquarters. Schulman also was art director for **"Going to Work in Space,"** a set of three commemorative Space Shuttle posters designed by Danne and Blackburn, Inc., which received **first place** in the "visual design, graphics" category. **Images of Saturn from Voyager 2,** a NASA FACTS leaflet designed by Ice House Graphics for the publications section at Headquarters placed **second** in the same category.

Two new NASA special publications have been issued: **Voyages to Saturn** by David Morrison and **Capturing Energy from the Wind** by James Schefter. Voyages to Saturn (NASA SP-451) presents chronologies and mission science summaries for each of the Voyager encounters with Saturn: Voyager 1 in November 1980 and Voyager 2 in August 1981. This book includes an index and almost 200 images, one-third of which are in color. For sale by the Superintendent of Documents, U.S. Government Printing Office, this volume is priced at $9.50. Capturing Energy from the Wind (NASA SP-455) is a semi-technical study of wind turbines as an energy source for the United States. Beginning with a brief history of this technology, the author explains the developmental work done by NASA, universities and private companies under NASA technical guidance to reach the goal of this research: create a wind turbine industry capable of producing electricity competitive with conventional and nuclear energy sources. Also for sale by the Superintendent of Documents, this volume is priced at $6.00.

George F. Page has been appointed **Deputy Director of NASA's Kennedy Space Center,** Fla. Director of Shuttle Operations at Kennedy since 1979, Page was launch director for the first three launches of the Space Shuttle. Page was named Director of Unmanned Launch Operations in 1975, and directed more than 54 major launches from Kennedy and the Western Test Range at Vandenberg Air Force Base, Calif., during the next four years.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
Lansing M. Carson and F. Elvin Krasin .. Motorola, Inc., Scottsdale, Ariz.	Discriminator aided phase lock acquisition for suppressed carrier signals	4,336,616	NRO/JPL
Richard S. Beitler, Frederic J. Sellers ... and George W. Bennett, General Electric, Cincinnati, Ohio	Control means for a gas turbine engine	4,338,061	LeRC
Robert L. Dotts and Jack W. Holt ...... Rockwell International, Downey, Calif.	Improved attachment system for silica tiles	4,338,368	JSC
Frederic S. Dawn and James V. Correale . NASA/JSC	Absorbent product and articles made therefrom	4,338,371	JSC
Madan M. Sharma .... TRW, Inc., Redondo Beach, Calif.	Optical crystal temperature gauge with fiber optic connections	4,338,516	JSC
Lien C. Yang .... Caltech/JPL, Pasadena, Calif.	Method and device for destructive detection of a substance	4,338,568	NRO/JPL
Harold G. Bush and .... Richard E. Wallsom, Vought Corp., Hampton, Va.	Mechanical end joint system for structural column elements	4,340,318	LaRC
Charles A. Barrett, Carl E. Lowell ...... and Abdus S. Khan, National Research Council, Washington, D.C.	NiCrAl ternary alloy having improved cyclic oxidation resistance	4,340,425	LeRC

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OC-102)	March 22	KSC	OSS-1
*Columbia (OC-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-B, Telesat-E

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* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
Telesat-G (Anik-D1)	August 26	Delta	ESMC	Canada communications. Reimbursable.
Intelsat V-E	September 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-E	November 18	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-F	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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* Successful launch

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Unsinkable Raft

The design for a unique round life raft, credited with saving 230 lives in the last five years, was based in part on NASA technology developed during the Apollo program. Ocean-landed astronauts left the Apollo command module and waited in inflatable rafts for pickup by helicopter. These rafts, however, tended to overturn under the force of the helicopter's downwash. Subsequently, NASA's Johnson Space Center developed a new method of raft stabilization to counteract this, for which NASA received a patent.

Working independently, inventor Jim Givens of Tiverton, Rhode Island, developed a very similar system. He patented his own invention and then obtained an exclusive patent license for use of the NASA technology.

The 75-lb. Givens Buoy Life Raft* consists of a canopied topside and an underwater hemispheric ballast chamber. Its heavy ballast stabilization system negates capsizing. A flapper valve admits large amounts of water to the hemispheric chamber to provide ballast to keep the center of gravity consistent. The stabilization system compensates for changes in wave angle and for weight shifting as raft occupants move about.

This raft cannot overturn in normal seas. In the photo above, Coast Guard personnel try repeatedly to capsize the raft but fail. As proven repeatedly in survival operations, the raft automatically rights itself if overturned by waves of exceptional strength.

The Givens Buoy Life Raft has capacities ranging from 6 to 20 persons; a simple pull line triggers the automatic inflation process which takes 12 seconds to complete. It is manufactured by RPR Industries, Inc., Apex, N.C.

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*NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

NASA
National Aeronautics and
Space Administration

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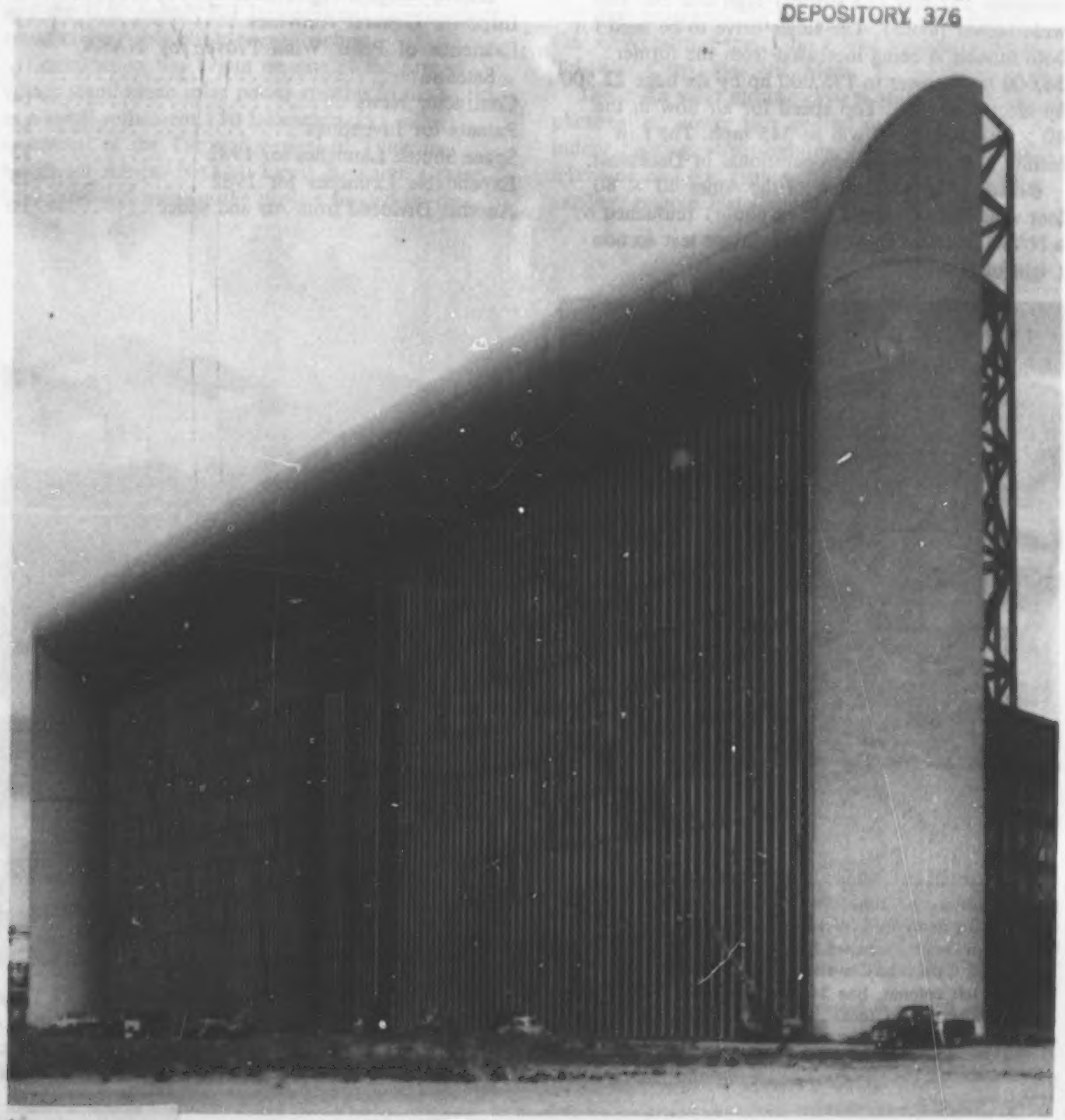

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About the Cover

Nearing completion at NASA's Ames Research Center, Mountain View, Calif., is an addition to the world's largest wind tunnel which will nearly double its size. The resultant tunnel, known as the National Full-Scale Aerodynamics Facility, will actually be two tunnels: the existing 40 × 80 foot section and the new test section measuring 80 × 120 feet in cross section, large enough to test a medium size commercial transport with engines running. This new test section terminates in a new air intake that measures 132 feet (13 stories) high and 362 feet wide (cover photo). The single drive to be used for both tunnels is being increased from the former 36,000 horsepower to 135,000 hp by six huge 22,500 hp electric motors. Top speed for air flow in the 40 × 80 foot tunnel will be 345 mph. The new facility is expected to be operational in December.

Below, is an aerial view of the Ames 40 × 80 foot wind tunnel (upper left in photo) retouched by a NASA artist to show the new larger test section (right of photo).

Corrections: In the June 1982 edition of *NASA Activities*, the following items need correction. Page 19, right column, line 4 should read: Launched Feb. 4, 1970 from the Western Test Range, Calif., the Cleveland-developed SERT II . . ." Page 26, left column, line 24-25 should read: "Weighing 10,000 kilograms (11 tons) . . ."

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NASA Technology May Help Third World Nation Avert Energy Crisis

NASA technology in alternative energy sources may help a third world nation better survive an impending energy crisis.

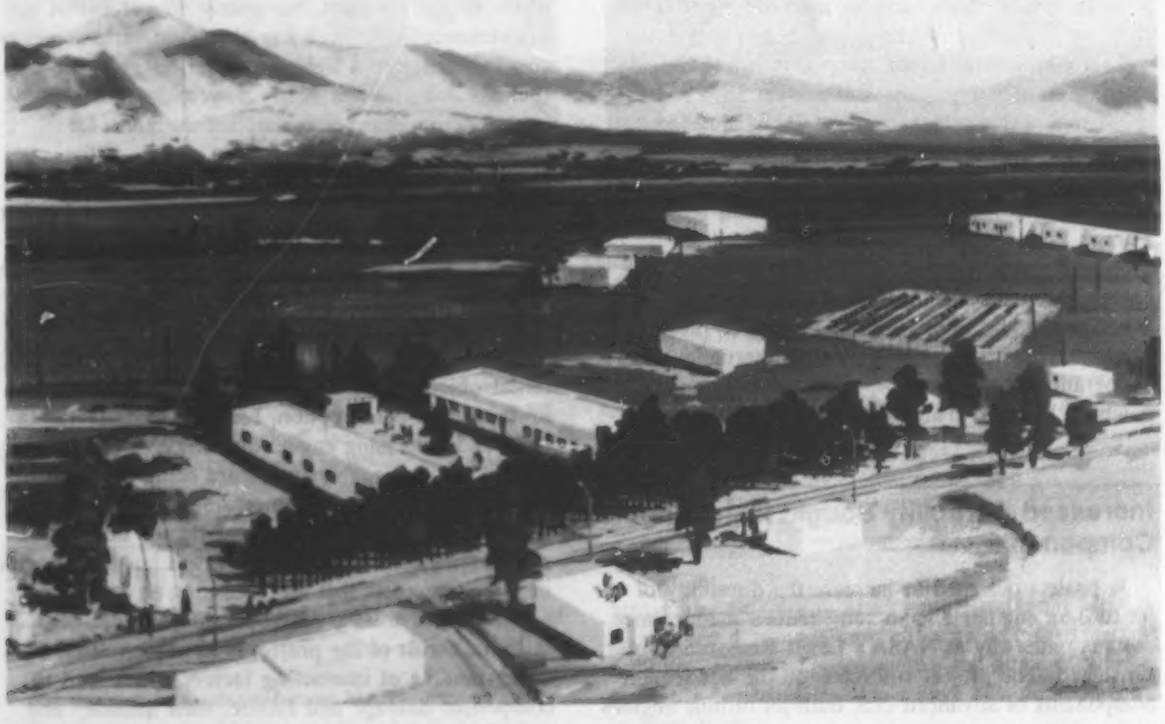
For Tunisia, North Africa, it is predicted that the country's known reserve of crude oil will no longer meet their demands by 1990. Tunisia relies on petroleum to produce electricity. The projected shortage would force the nation to become a net importer to meet their growing needs. However, a new test program begun between Tunisia, NASA and the U.S. Agency for International Development could change this bleak energy picture.

Construction has begun on one of the largest village stand-alone solar power systems in the world, at a small settlement 150 kilometers (93 miles) southwest of the Tunisian capital of Tunis in Northeast Africa. NASA's Lewis Research Center, Cleveland will manage the project funded by the Agency for International Development and the government of Tunisia. AID will underwrite three fourths of the $1.9 million cost, and the government of Tunisia will pay the remaining one fourth.

The village, known as Hammam Biadha, will be provided with solar electricity as part of an ongoing, five-year-old photovoltaic power systems program sponsored by the Agency for International Development and managed by Lewis. Objective of the international effort is to investigate the feasibility of photovoltaic power systems as cost-effective alternatives to petroleum-based electrical systems in remote areas.

Prime contractor on the project is Solar Power Corp., Woburn, Mass., and a lead subcontractor is Tri-Solar Corp., Bedford, Mass.

The main solar electric system will provide photovoltaic power to a central installation for indoor lighting, street lighting, refrigeration, radio, television and water pumping for the village. Two smaller, remote installations will provide for



Artist concept of one of the world's largest stand-alone solar power systems currently being constructed in a small settlement 150 kilometers southwest of the Tunisian capital of Tunis in Northeast Africa.

agricultural applications on a nearby farm and orchard. In total, the systems will be capable of 25 to 30 peak kilowatts of usable electricity. All solar electric systems are expected to be in place and operational by October of this year.

In addition to the photovoltaic power systems, two small wind turbines will be installed to pump water for the irrigation of two greenhouses. Also, two small solar heating systems will be supplied, one providing hot water for the village clinic, and the other providing warmth for the clinic examining rooms and nurses' living quarters.

Centerpiece of the main photovoltaic power system is the array of 30,240 wafer-thin solar cells which can convert the rays of the sun directly into usable electricity. The 100-millimeter (4-inch) diameter cells are encapsulated into 840 modules, each measuring approximately 1.20 by .45 meters (3.9 by 1.5 feet). Each module contains 36 solar cells and produces 31 watts of peak power at 12 volts dc. Peak power is produced in full sunshine with the sun's rays striking the solar cell at a 90-degree angle or perpendicular to the surface of the cell.

Hammam Biadha is composed of three sectors: a public sector which includes a school for 400 children, a mosque, a clinic, and a public water well; a commercial sector composed of two retail stores, a new barber shop, and a grain mill; and a residential sector which provides living quarters for the town's 60 residents.

According to Lewis Research Center's Larry R. Scudder, project manager of the Tunisian Renewable Energy Project, "the goal is to investigate the economic, social and technical value of alternative energy resources and technologies in assisting development and improving the quality of life in Tunisia. The project demonstrates international cooperation in the use of space technology and its potential benefits to mankind."

Increased Durability Sought in Jet Engine Components

A project designed to increase the durability of jet turbine engines and thereby reduce maintenance costs is underway at NASA's Lewis Research Center, Cleveland. The project will focus on the hot section components of advanced U.S. built jet turbine engines and will channel its efforts in five major areas: structural analysis, surface protection, combustion, turbine heat transfer and instrumentation.

The $45 million Turbine Engine Hot Section Technology Project will be conducted over a seven-year period. To implement this research, between 25 and 30 contracts will be awarded to competing companies; approximately 50 percent of the research will be performed directly by NASA Lewis in-house staff. Lewis is NASA's lead center for aeronautical propulsion research.

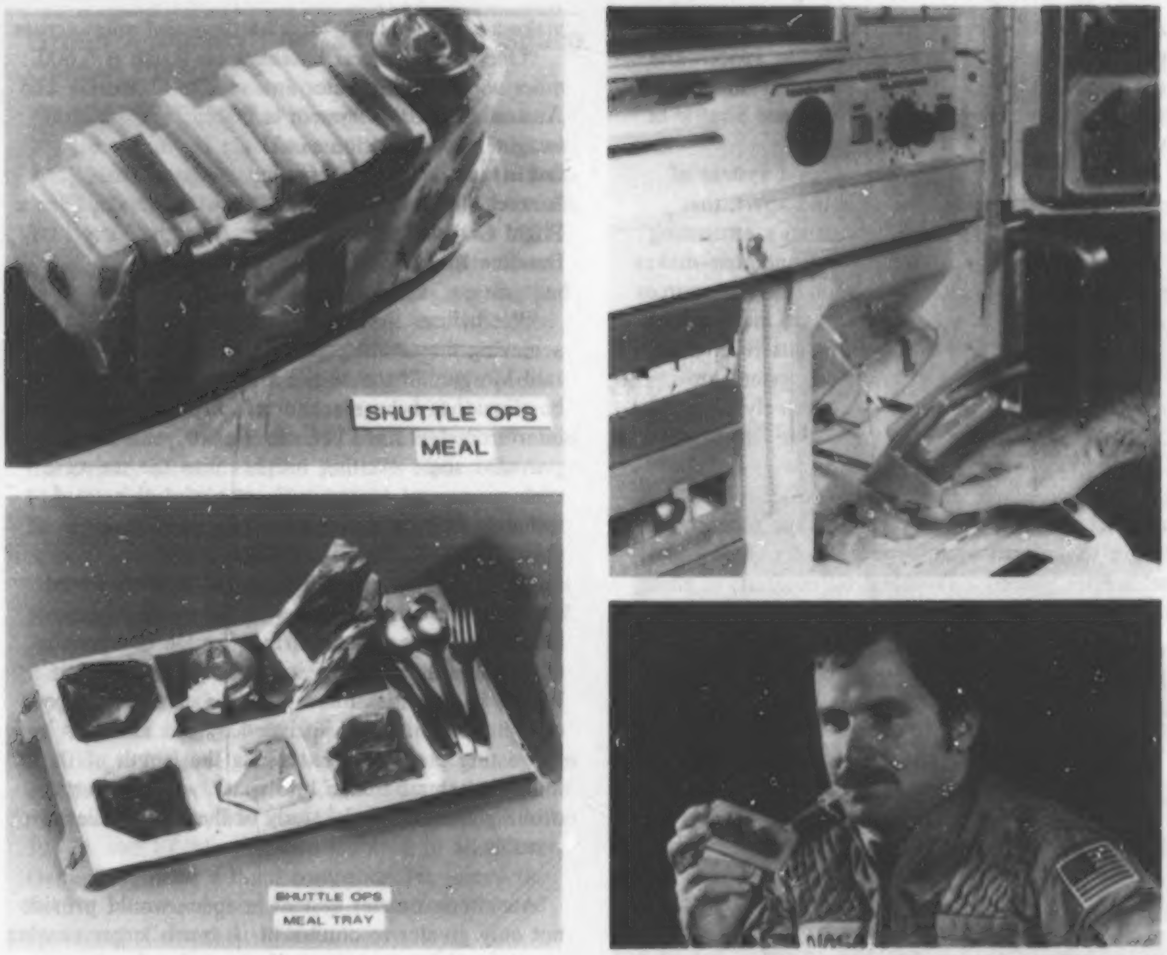
The hot section of a turbine engine is located near the aft portion of the powerplant. It includes both the combustor, in which fuel ignites in combination with pressurized air, and the turbine, located immediately aft of the combustor, which drives the inlet fan and the air compressor system. Components targeted for study are the liners of the combustor, and the blades and vanes of the turbine.

"Improvements that have led to increased efficiencies for the turbine engine have resulted in hot section parts being exposed to higher temperature and pressure levels," explains NASA Lewis project manager Daniel J. Gauntner. "These higher levels produce an operating environment increasingly hostile to those parts in the hot gas flow path. These hot section components account for only 20 percent of the engine's weight, but nearly 60 percent of its maintenance cost." Refining the basic turbine engine concept to create a lighter, quieter, cleaner, more fuel-efficient and less costly powerplant has been a goal of aeronautical engineers and designers for the past three decades.

During the 1950s and early 1960s jet engine designers aimed at improved performance and lower engine weight. In the late '60s and early '70s, demands for less noisy engines and cleaner emissions were added to the performance and weight goals. Today, designers working on the next generation of "energy-efficient engines," are advancing those initial objectives with the added responsibility of lowering fuel consumption, reducing manufacturing costs and increasing engine durability.

"All of these goals have or are being achieved to some extent," says Gauntner, "but their fulfillment is creating greater wear and tear on the hot section components of the engine. The result has been engine maintenance costs that are becoming an increasingly larger part of total airline operating costs."

Initial thrust of the project is to improve the understanding of interacting factors which lead to component damage and failure, then quantify and describe them. Finally, researchers must be able to predict how and when damage could occur.



Space Shuttle Meals—For operational Space Shuttle flights which begin this November, astronauts will use a newly designed meal storage and preparation system. At top left is closeup view of stowed Space Shuttle food items. Astronauts take the individual packets from the overall package and place them in a six-compartment tray (bottom left photo) for preparation and consumption. This meal is a Day 3, Meal C, tray consisting of smoked turkey, mixed vegetables, cream of mushroom soup and strawberries. First flight for this food storage arrangement and tray is the fifth flight in November. At top right is a closeup view of the rehydration unit to be used in meal preparation on operational Shuttle flights. The unit is located on the middeck of Columbia and Challenger. A Shuttle meal tray can be seen at upper right in this photo. At lower right, Mike Fohey of Technology, Inc., demonstrates how a Shuttle astronaut on an operational mission would drink a beverage. After rehydrating the dried powder with a needle, the Shuttle crew member would pick up the removable tray compartment and hold it like a cup or glass and drink through the straw-like tubing.

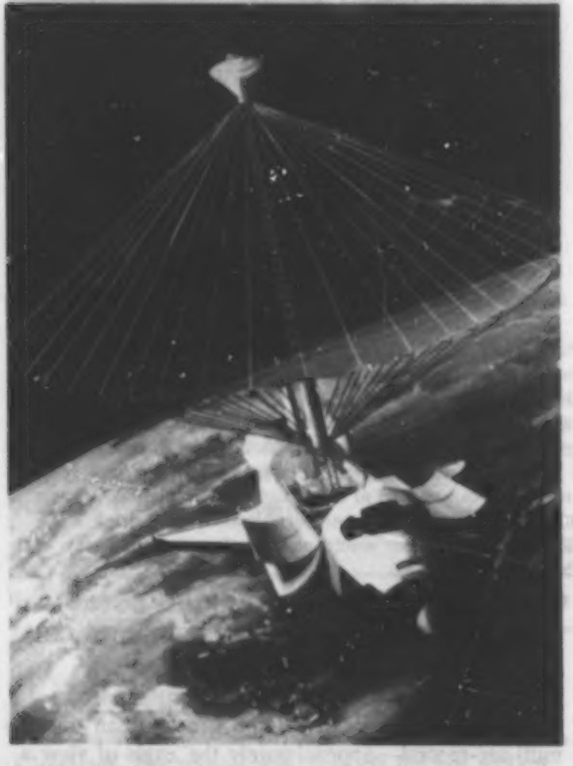
Closeup View of Universe Possible by 1990s

By the next decade, a future NASA project in radio astronomy could be providing detailed coverage of the universe. The Very Long Baseline Interferometer, a system linking a large orbiting radio astronomy antenna to one or more antennas on Earth, could provide resolution greater than one milli-arc-second—approximately the angle of view a person in Los Angeles would have of a dime placed in New York.

A working group on this project was chartered in 1981 by NASA's Office of Space Science and

Applications to develop the rationale and technical plan for placing an interferometer in space. The group has proposed sending into orbit an interferometer experiment aboard the Space Shuttle in the late 1980s.

A long baseline interferometer is a system of antennas, placed thousands of miles apart, that simultaneously study radio frequencies emanating from the heavens. This linkage of antennas makes possible high-resolution images of celestial sources that can't be achieved with a single, independent radio astronomy antenna. The signals received by each antenna in an interferometer system are recorded and synchronized by extremely accurate atomic clocks. These signals are later added together in a special way to produce radio images of the celestial sources being studied. The longer the distances, or "baselines," between the antennas, the larger the effective telescope diameter. Two radio telescopes, placed a thousand miles apart, in effect make a radio antenna "dish" a thousand miles across.



Artist's concept of a prototype antenna to be used in a radio astronomy system known as a Very Long Baseline Interferometer tested aboard the Space Shuttle. Such an experiment has been proposed for the late 1980s, with a permanent operational system in orbit by the late 1990s.

"One of the longest baselines on Earth is 6,600 miles with interferometer antennas in California and Australia, and that system is highly sensitive. But imagine the resolution you'd get if you were to link it with an antenna far out in space," said Dr. Samuel Morgan, physicist at NASA's Marshall Space Flight Center and study manager for the Very Long Baseline Interferometer project.

"We believe that space is the only answer to achieving the ultimate potential of radio astronomy," said Morgan, "because the maximum length of baselines has been reached on Earth. Ground-based interferometers have been in use for years and have provided some exciting insights into the universe such as quasars, enormously powerful objects of radiation far out into space, possibly at the edge of the universe. According to Einstein's special theory of relativity, the speed of light is the ultimate speed that can be achieved. However Earth-bound interferometers have suggested that certain components of some quasars studied split off from the main bodies at velocities that appear to exceed the speed of light. Scientists are intrigued by this kind of interesting puzzle. By extending the length of the interferometer baseline into space with an Earth-orbiting antenna closer study of these anomalies is possible.

An interferometer system in space would provide not only greater resolution but a much larger viewing area. Antennas are generally placed only on temperate-zone land masses where scientific activities are concentrated. Since most of the heavy science interest in the world is found in the United States, Europe and Asia, which occupy only the northern hemisphere, only east-west separations of antennas exist. Limited science activities on relatively limited land masses in the southern hemisphere make north-south separations of antennas—with the additional views of the heavens they could offer—virtually nonexistent. A space-based interferometer in a 5,000-kilometer orbit, however, would overcome that problem.

"Ultimately we would like to place an interferometer about 200,000 kilometers out, which would give us a radio astronomy capability that far exceeds what we have today," said Morgan. "An interferometer placed that far from Earth may be possible by the turn of the century."

Griffin Assumes Post as Johnson Space Center Director

Gerald D. Griffin, has assumed the post of Director, Johnson Space Center, Houston in August. Prior to returning to NASA in June 1982, Griffin was Vice President for Systems Engineering and Management, Scott Science and Technology, Inc., Lancaster, Calif. He previously served with NASA from 1964 to 1981. From 1977 to 1981, Griffin was the Deputy Director of the Kennedy Space Center, Fla. From July 1980 to June 1981 he concurrently served as Associate Administrator for External Relations at NASA Headquarters in Washington.

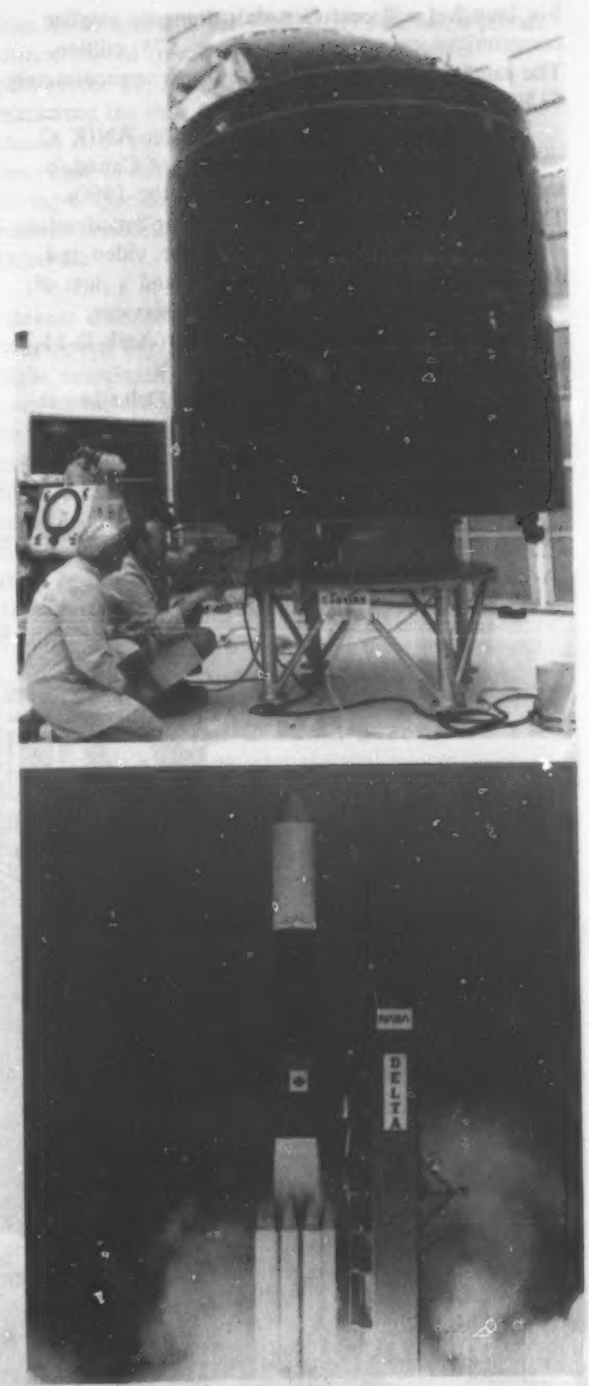
Griffin was Deputy Director of the Dryden Flight Research Center, Edwards, Calif. from 1976 to 1977. At NASA Headquarters he was Deputy Associate Administrator for Manned Spaceflight (Operations) from 1975 to 1976, and from 1973 to 1975 served as Assistant Administrator for Legislative Affairs.

Prior to his first Headquarters assignment, he was a flight director in Mission Control on all 11 Apollo missions. He served as lead flight director on Apollos 12, 15 and 17. He was also involved in all of the Gemini flights as a flight controller. He joined the NASA Johnson Space Center (then the Manned Spacecraft Center) in 1964.

Griffin received a bachelor's degree in aeronautical engineering from Texas A&M University in 1956 and served four years as an officer in the U.S. Air Force. He was an aerospace engineer with Douglas Aircraft Co., the Lockheed Missile and Space Co., and General Dynamics before joining NASA.

NASA Signs Launch Agreements for Five Canadian Satellites

NASA and Telesat Canada, the operator of the Canadian domestic telecommunications satellite system, have signed launch services agreements for the launching of Telesat's ANIK satellites. Under these agreements, NASA will launch five telecommunications satellite payloads, four on the Space Shuttle and one on the Delta launch vehicle. These



Technicians perform prelaunch checkout (top photo) of Telesat-G (Anik D-1) spacecraft, launched from NASA's Kennedy Space Center Aug. 26 aboard a Delta expendable launch vehicle. Launch of Telesat-G at 7:10 EST (bottom photo).

five launches will cost Canada's domestic satellite communications corporation about $75 million. The satellites themselves will be worth approximately $130 million.

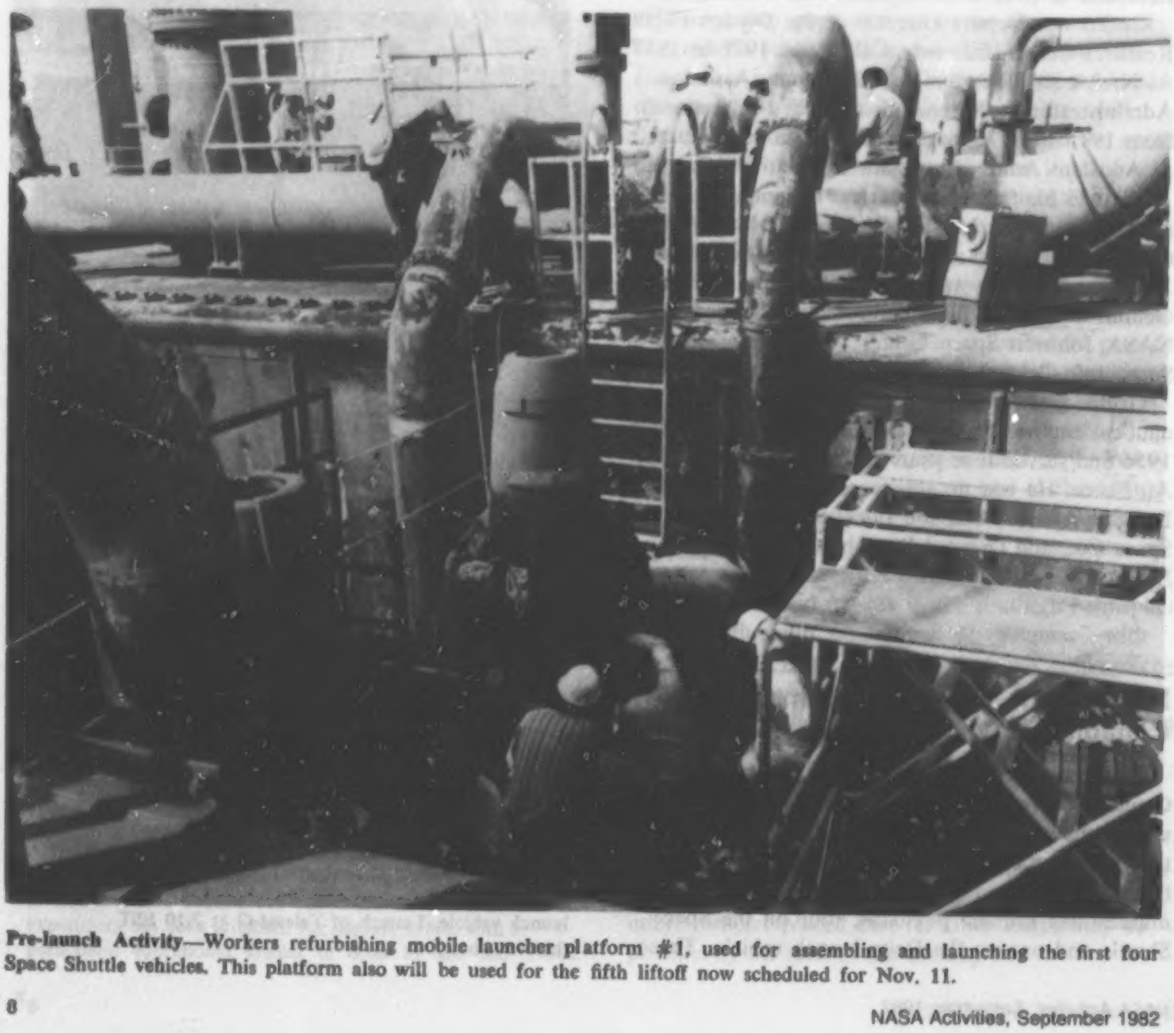
Telesat's third and fourth generation ANIK C and D satellites will be the backbone of Canada's satellite communications system until the 1990s. They will carry new pay TV and other broadcasting services, as well as point-to-point voice, video and data links, private business networks and a host of other specialized telecommunications services.

The first of the D series, Telesat-G (Anik D-1), was launched August 26 from NASA's Kennedy Space Center, Fla., aboard a Delta launch vehicle. The next Telesat launch, Telesat-E (Anik-C1), will be one of two commercial communications satellites launched by the Space Shuttle on its fifth flight in November.

The agreements were signed at the Telesat Canada headquarters in Ottawa, Ontario, Canada, by Dr. Stanley I. Weiss, Associate Administrator for Space Transportation Operations for NASA and Eldon D. Thompson, President, Telesat Canada.

NASA, German Research Ministry Sign Cooperative Mission Agreement

A memorandum of understanding has been signed in Vienna, Austria, by James M. Beggs, NASA Administrator, and Hans-Hilger Haunschild, State Secretary, German Federal Ministry for Research and



Pre-launch Activity—Workers refurbishing mobile launcher platform #1, used for assembling and launching the first four Space Shuttle vehicles. This platform also will be used for the fifth liftoff now scheduled for Nov. 11.

Technology (BMFT), establishing cooperation on an astrophysics mission designated Roentgensatellit (ROSAT). ROSAT is scheduled to be launched by the Shuttle-based Space Transportation System in 1987.

The ROSAT mission will advance astrophysics through the study of X-ray emissions from non-solar celestial objects with an X-ray observatory which will survey the sky for X-ray sources and will point at specific sources for extended periods of time.

The main instrument of the observatory will consist of a Wolter type I X-ray telescope with a carousel focal plane assembly carrying two imaging proportional counters and one high resolution imaging detector. The main telescope will be supplemented by an XUV wide field camera which is oriented parallel to it.

The ROSAT project will be carried out as a cooperative venture between NASA and BMFT. BMFT will provide the ROSAT spacecraft and the X-ray telescope and NASA will provide a high resolution imaging detector and Space Shuttle launch services. The Science and Engineering Research Council of the United Kingdom will provide the XUV wide field camera.

The ROSAT will operate in both a survey mode and a pointed mode. The BMFT will compile an X-ray source catalog from the data obtained during the survey portion of the mission. NASA and BMFT will each invite proposals from the scientific community to carry out investigations during the pointing phase of the mission.

Goddard Space Flight Center, Greenbelt, Md., and the German Aerospace Research Establishment (DFVLR) are responsible respectively for management of the U.S. and the German portions of the program.

ROSAT, in addition to the Galileo and Active Magnetospheric Particle Tracer Explorer missions, are current examples of a long history of successful cooperative projects between NASA and BMFT.

Inspector General Activities

The following reports are of completed recent investigations by NASA's Office of the Inspector General.

Possession of Alleged Lunar Materials

After receiving information from the curatorial branch at NASA's Johnson Space Center, Houston, the Office of the Inspector General opened an investigation of the proposed sale of so-called moon dust. In an article in the *Wall Street Journal*, a private citizen offered to sell a small amount of white powder for $75,000. The broker claimed to be marketing the dust for individuals who had purchased it in 1974 in Delaware. The substance was described as lunar dust vacuumed from space suits during a specific post-flight cleaning and examination process conducted by the suit manufacturer in Delaware.

The Office of the Inspector General reviewed relevant documents and inventory records and interviewed key personnel responsible for the post-flight examination of flight equipment. This process verified the space suits never left the flight center to be cleaned at the Delaware site. All post-flight examinations of the suits took place at the NASA flight center. Furthermore, no discrepancies were identified in the accountability procedures at the flight center for handling lunar material. Since no theft or loss occurred, efforts by the Office of the Inspector General did not extend beyond this assurance level.

Procurement Violation

Recent investigation at a NASA Center identified a contractor employee who violated procurement practices by disclosing cost estimates of NASA construction projects to another contract bidder. Within one week, effective collaboration by NASA management and the Office of the Inspector General resolved the problem. The contract employee was terminated, and the contractor who received the information was declared a "non-responsible bidder."

Existence of Polar Wind Proven by NASA Satellite

Flow of particles from the ionosphere into space, a phenomenon called the polar wind and theoretically predicted over a decade ago, has been recorded for the first time by instruments aboard NASA's Dynamics Explorer satellite. Called Retarding Ion Mass Spectrometers, these instruments were specially designed to seek out the polar wind.

The spacecraft carries three spectrometers, one on each end and one mounted on the side to scan as the satellite spins about its axis. This enables the satellite to "see" in all directions and to sample gas hitting the satellite from the side facing the Earth. Plasma from this direction is the polar wind.

Data recorded by the spectrometers prove that there is a continual interchange of particles from one part of the Earth's near-space environment to another so that neither the ionosphere nor the magnetosphere can be understood in isolation.

The Dynamics Explorer program is designed to provide new knowledge about the exchange of energy, electric currents, electric fields and charged particles in the magnetosphere, ionosphere and atmosphere.

Dynamics Explorer flies an elliptical orbit over the Earth's poles. The highest point of the satellite's orbit is approximately 22,000 kilometers (14,000 miles or 3.5 Earth radii), well into the region of the inner magnetosphere dominated by high energy plasma. At lower points in its orbit, the satellite passes through the cooler, lower energy plasma of the ionosphere and plasmasphere.

A companion satellite, Dynamics Explorer 2, is in a lower polar orbit for coordinated studies of plasma and the aurora.

Twenty-five years ago when gases of charged particles were first discovered in the Earth's space environment, the question arose on the source of the plasma. For a long time, it was thought the magnetosphere contained only very high-energy hydrogen and helium particles that came from the Sun via the solar wind. Improved instrumentation led to the discovery in 1970 of high-energy oxygen ions in a form not produced by the Sun. This finding suggested that some constituents of the magnetosphere must come from within the Earth's environment, from the ionized upper atmosphere.

Dynamics Explorer 1, undergoing preflight checkout. Launched August 1981, data from this spacecraft has proven the existence of polar wind—the flow of plasma from the ionosphere into space.

One generally accepted theory, proposed by Dr. Peter Banks and Dr. Thomas Holzer in 1969, explained how the ionosphere could feed plasma into the magnetosphere. They calculated that small electric fields in the polar regions could drive particles up the magnetic field lines. This acceleration might give ions just 1 electron volt (eV) of energy, but that is enough to set a hydrogen ion moving at about 14 kilometers per second (31,000 miles per hour). These scientists named the flow of gas from the ionosphere into the space the polar wind.

Banks with coinvestigator Dr. C. R. Chappell of NASA's Marshall Space Flight Center, Huntsville, Ala., developed Dynamics Explorer's spectrometer. The necessary requirements were the capability to do mass discrimination at very low energies of 0-50 eV, to see in all directions, and to offset the effects of spacecraft charging.

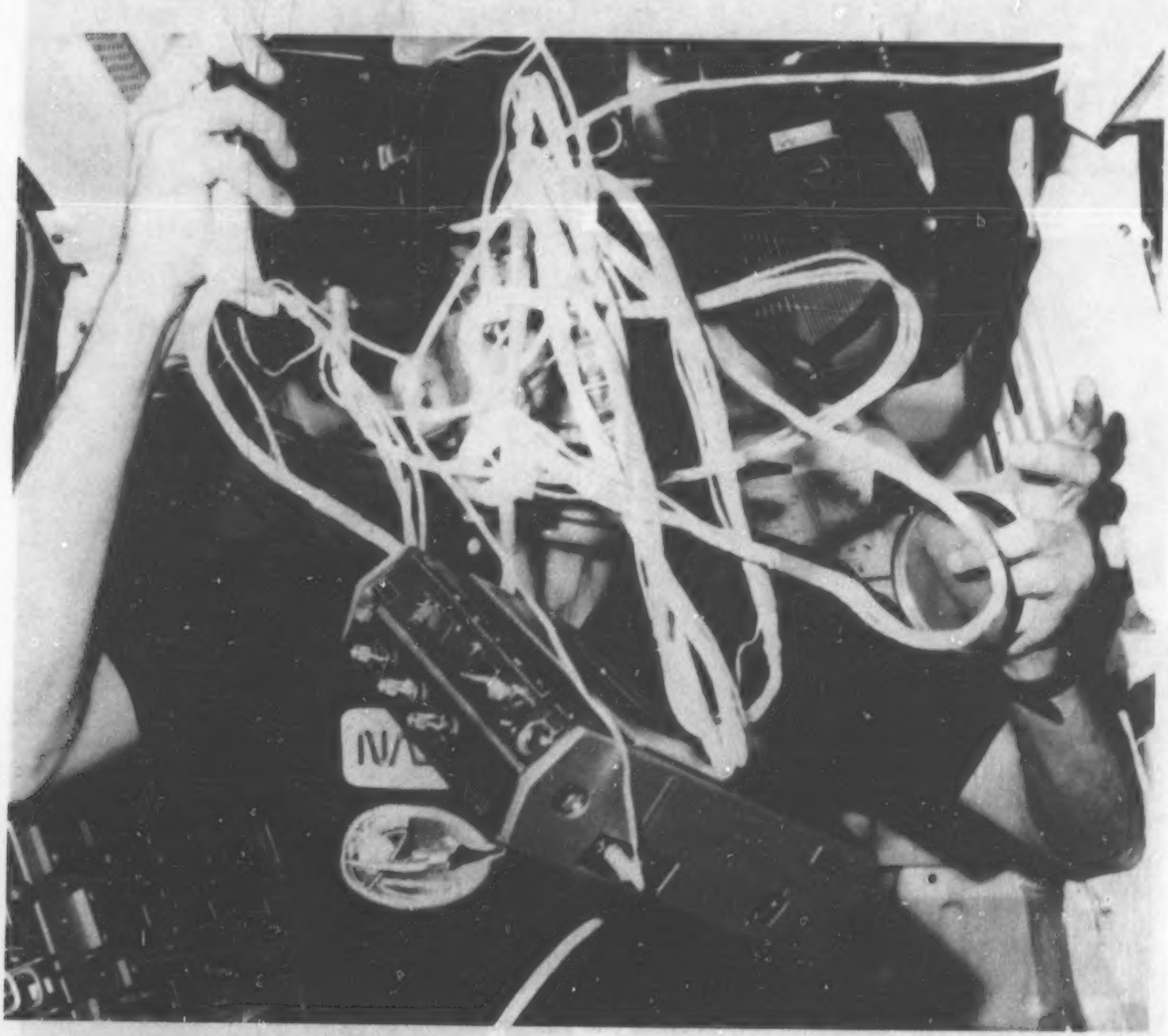
In the past, instruments capable of good mass resolution of low-energy ions were flown only in the ionosphere. Instruments flown in the magnetosphere looked only for ions in the high energy range from tens of electron volts to 10,000 eV and were not capable of subtle mass separation. Dynamics Explorer carries state-of-the-art mass spectrometers to higher altitudes than ever before.

Normally, satellites at high altitudes develop a positive electrical charge of a few volts that repels positively charged ions. Thus, an instrument cannot detect low-energy ions unless the spacecraft's charge is neutralized. Chappell and his colleagues overcame this difficulty by applying a small negative charge to a gold disk around the opening of the spectrometer sensor. This neutralized the spacecraft's charge, and the spectrometer readily detected low-energy ions. It also detected a very high ion flux over the polar regions, where the polar wind had been predicted to originate.

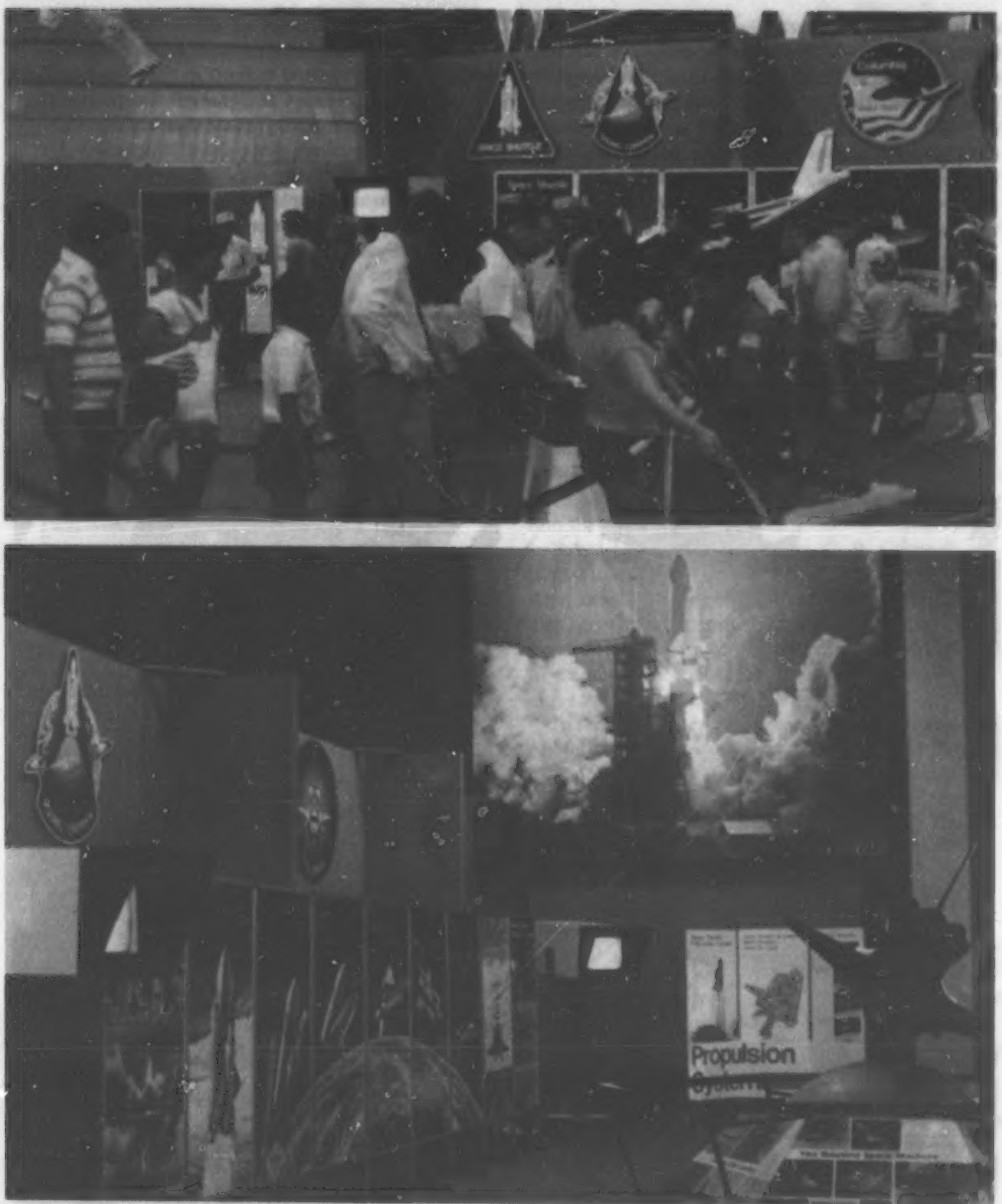
The spectrometer saw hydrogen and helium ions flowing upward at the predicted speed of about 10 km per second (22,000 mph). Surprisingly, the instruments also saw ions streaming out above the polar cap at much higher speeds than expected, up to 50 km per second (112,000 mph). Scientists are not yet sure about the origin and cause of this unexpected phenomenon. Though the Dynamics Explorer observations confirm the existence of the polar wind, many unanswered questions remain. How does the polar wind supply ionospheric particles to the distant magnetosphere? What part does the polar wind play in the Earth's complex responses to the changing Sun?

The polar wind is another fundamental factor in the study of solar-terrestrial interactions. The Dynamics Explorer satellite and spectrometer instruments are expected to function for a year or more. Further measurements and analysis should give new insight into the role of particle acceleration and energy transfer throughout the Earth's space environment.

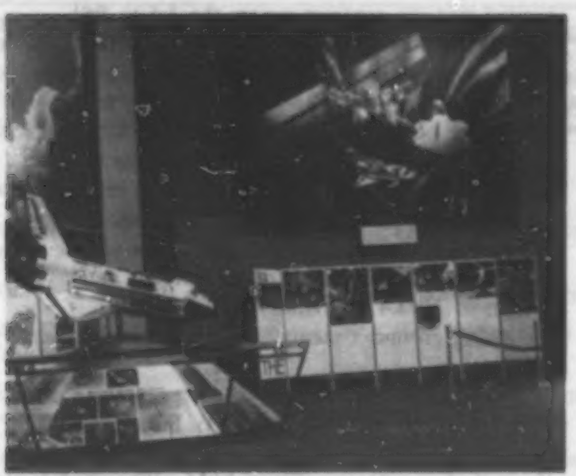
The Dynamics Explorer is managed for NASA's Office of Space Science and Applications by the Goddard Space Flight Center, Greenbelt, Md.



Space Spaghetti—Astronaut T. K. Mattingly, commander of the fourth Space Shuttle mission, loses his cap amidst a maze of wiring ("space spaghetti"), tape recorder and camera equipment floating in the weightless environment onboard the Columbia. This 35-mm photo was exposed by astronaut Henry Hartsfield, fourth Shuttle mission pilot. The pair spent seven days in space for NASA's final orbital test flight.



NASA at the World's Fair—Scenes from NASA's exhibit (this page and opposite) at the World's Fair in Knoxville, Tenn., May 1 to Oct. 31. The 4,000-square-foot exhibit, on display in the Technology and Life Style Pavilion, focuses on "future uses and the role of the Space Shuttle. July was "Shuttle Month" at the Fair. Over one million people will have viewed the NASA exhibit by the Fair's end.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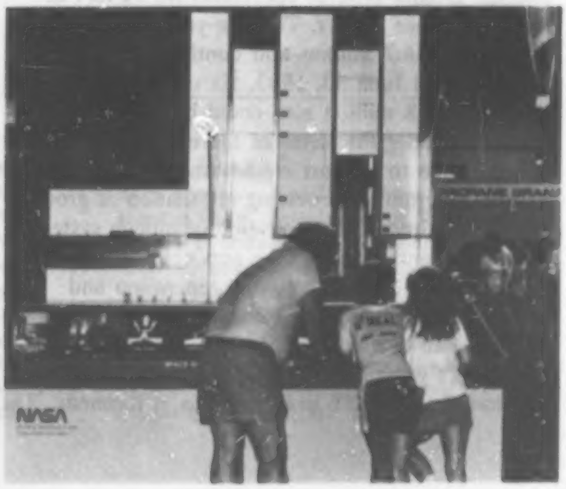
NASA

Contractor News

Hamilton Standard Div., United Technologies Corp., Windsor Locks, Conn., has been awarded a $7,451,000 contract by NASA's Lewis Research Center, Cleveland, to supply large-scale propeller assemblies for a potential future flight program. Under a separate contract, a major airframe manufacturer and an engine manufacturer will work with Hamilton Standard. NASA's advanced turboprop research is aimed at developing technology for advanced, high-speed propellers suitable for use on future civilian and military aircraft. Fuel savings of 15 to 20 percent over current turbofan engines is expected.

Phase I of this two-phase contract includes: building a .6-meter (2-foot) diameter aeroelastic propeller model; design and fabrication of a large-scale 2.7-m (9-ft.) diameter propeller assembly with fixed pitch, ground-adjustable blades; and static and high speed wind tunnel tests of the large-scale blade and assembly. Phase II, which will begin at government discretion upon receipt of program authority and funding, would amount to $13,990,000. It would include delivery of three additional large-scale 2.7-m (9-ft.) diameter, variable-pitch rotor assemblies plus additional static and wind tunnel tests. In addition to these two phases, an optional $3,752,000 may be awarded for two more 2.7-m (9-ft.) diameter propeller assemblies designed to rotate opposite to those from phases I and II. If Phase II and the option are conducted, the entire program could run for five years. The work will be performed at Windsor Locks.

Boeing Services International, Cocoa Beach, Fla., has been awarded an extension to its contract to manage ground systems operations for NASA at Kennedy Space Center. The one-year extension is valued at $46.7 million and continues Boeing's contract until June 30, 1983. Six one-month options totaling $32.8 million also could be added to the contract. Under the terms of the contract, Boeing will continue to support NASA and the Space Shuttle program by providing installation of ground support equipment, modification of launch systems, operations and maintenance services for specific Space Shuttle support activities, operation and maintenance services for Kennedy facilities, and maintenance of launch systems.

Boeing's ground systems operations contract will be phased out by two new contracts at Kennedy. The ground systems contract covers the 1,500 BSI workers until November 1982. At that time, NASA's new base operations contract, now in competition, will combine some of Boeing's ground systems work with all or portions of other support service contracts at Kennedy. Award of the base operations contract is expected to be made in October. The remainder of Boeing's ground systems work force will continue their roles until July 1983 or until a new shuttle processing contract (see Contract News, Aug. edition of *NASA Activities*) will combine this remaining ground systems work with other Kennedy contracts.

Four companies have submitted proposals for a **base operations contract,** the first of three comprehensive contracts to be awarded by NASA's Kennedy Space Center, Fla., to strengthen the Space Transportation System launch function. The base operations contract will cover institutional support services, now provided by 13 different contractors, into a single mission contract which includes utilities, facilities, administrative services, technical operations, and health and protective services. The contract could cover a period of as many as 10 years and involve expenditures of more than $500 million over the life of the contract.

Proposals, opened June 17, were received from: **BENKO Joint Venture** (Bendix Field Engineering, Wackenhut Services, Inc., Planning Research Corp. and Computer Sciences Corp.), Cape Canaveral, Fla.; **Boeing Services International,** Cocoa Beach, Fla.; **EG&G,** Wellesley, Mass.; and **Lockheed Engineering and Management Services Co., Inc.,** Houston. The proposals are under review at Kennedy and a source selection may be made by early October. It is projected the base operations contract winner would begin work about mid November. The contractor selected would be fully responsible for management, operation, maintenance and engineering for Kennedy Space Center utilities, facilities, certain technical and administrative operations and health, fire and security services.

This is the first of three comprehensive contracts that NASA plans to establish at Kennedy as the most effective and economical method of conducting Space Shuttle missions when the system becomes operational. The other two single mission contracts will be a Shuttle Processing Contract responsible for refurbishment, assembly, checkout and launch of the Space Shuttle, and a Cargo Processing Contract.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title	Patent No.	Installation
Archibald L. Fripp, James B. Robertson and Roger A. Breckenridge, NASA/LaRC	Pyroelectric detector arrays	4,341,012	LaRC
William A. Brainard, NASA/LeRC	Improved refractory coatings	4,341,843	LeRC
John C. Evans, Jr., An-Ti Chai and Chandra P. Goradia, NASA/LeRC	High voltage planar multi-junction solar cell	4,341,918	LeRC
George D. Doland Lockheed Electric Co., Inc., Houston	Secure communications system	4,341,925	JSC
Fredercik C. Hallberg and John S. J. Benedicto, NASA/GSFC	Crystal cleaving machine	4,343,287	GSFC
Wilmer H. Reed, III, NASA/LaRC	Decoupler pylon: wing/store flutter suppressor	4,343,447	LaRC
Edwin J. Saltzman, NASA/ARC	Improved low-drag ground vehicle particularly suited for use in safely transporting livestock	4,343,506	ARC
Jerry L. Hudgins, NASA/MSFC	Apparatus for sequentially transporting containers	4,343,584	MSFC
Harry Levin and Larry B. Ford, Caltech/JPL	Thermal reactor and process	4,343,772	NRO/JPL
Liam R. Jackson, NASA/LaRC	Multiwall thermal protection system	4,344,591	LaRC
Taylor G. Wang and Daniel D. Elleman, Caltech/JPL	System for producing gas-filled hollow spheres	4,344,787	NRO/JPL

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OC-102)	March 22	KSC	OSS-1
*Columbia (OC-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-B, Telesat-E

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* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
*Telesat-G (Anik-D1)	August 26	Delta	ESMC	Canada communications. Reimbursable.
Intelsat V-E	September 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-E	November 18	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-F	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

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* Successful launch

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at any tiny percentage of the tax dollar. Here is an example:

Alternative Fuel Vehicle

Liquid methane could replace gasoline as a fuel source for automotive vehicles. A principal component of natural gas, methane costs less than one-half as much as gasoline and produces a cleaner emission than either gasoline or diesel fuel. A method of converting cars and trucks to liquid methane operation has been developed drawing upon the space technology used to produce cryogenic storage systems for NASA's Apollo and Skylab spacecraft and for the Space Shuttle.

Liquid methane is a cryogenic fuel that must be stored at a temperature 260 degrees below zero Fahrenheit. Beech Aircraft Corp., Boulder Division*, the designer of the liquid methane system, has received its first substantial contract for vehicle conversion from Northwest Natural Gas Co., Portland—25 vehicle conversions and a liquid methane refueling station. In addition to the 18-gallon fuel tank stored in the trunk, the liquid methane system includes a simple "under the hood" carburetor conversion. An optional twin fuel system is available which enables the operator to use either liquid methane or gasoline.

FOR LIQUID
METHANE ONLY

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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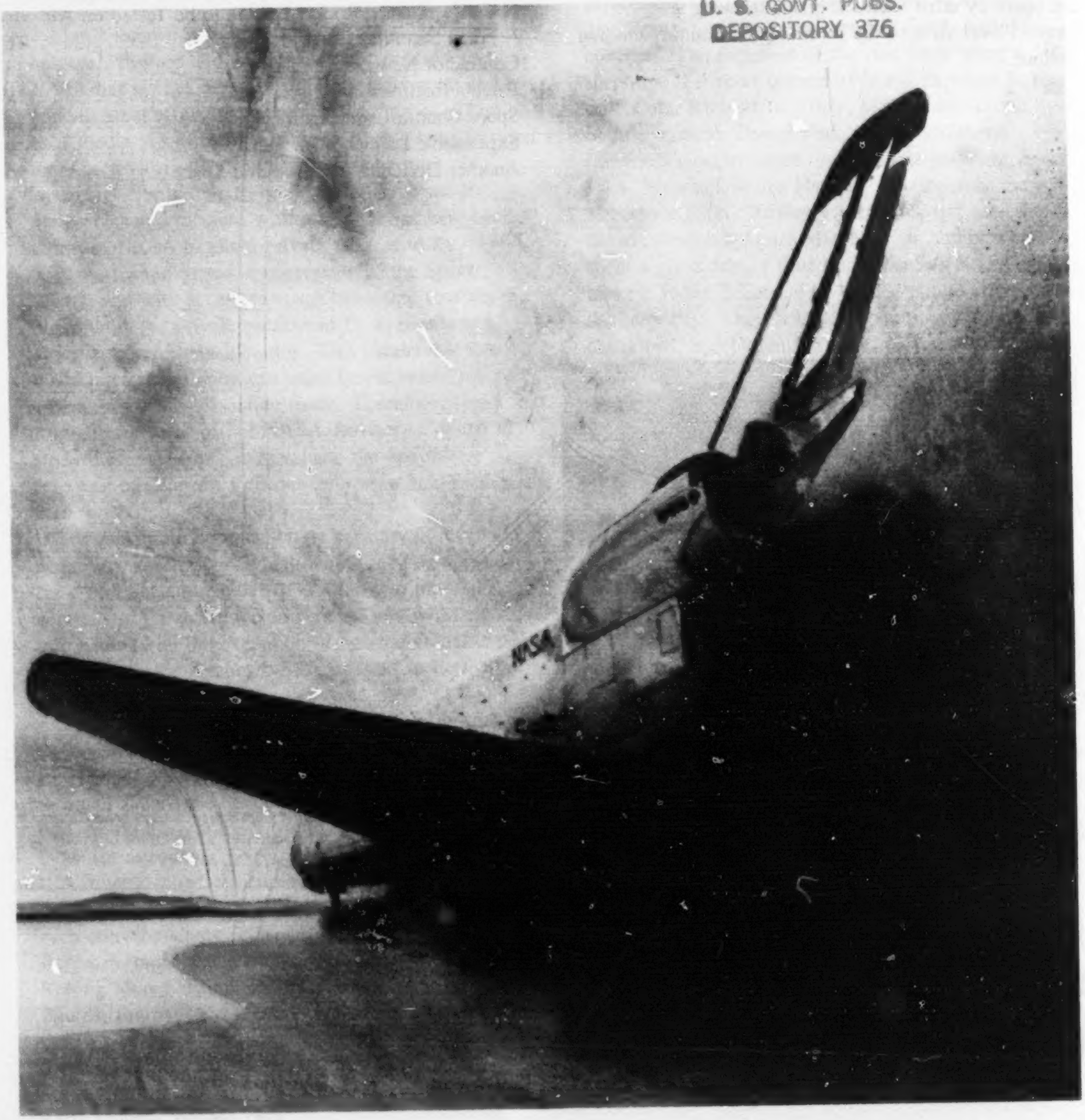

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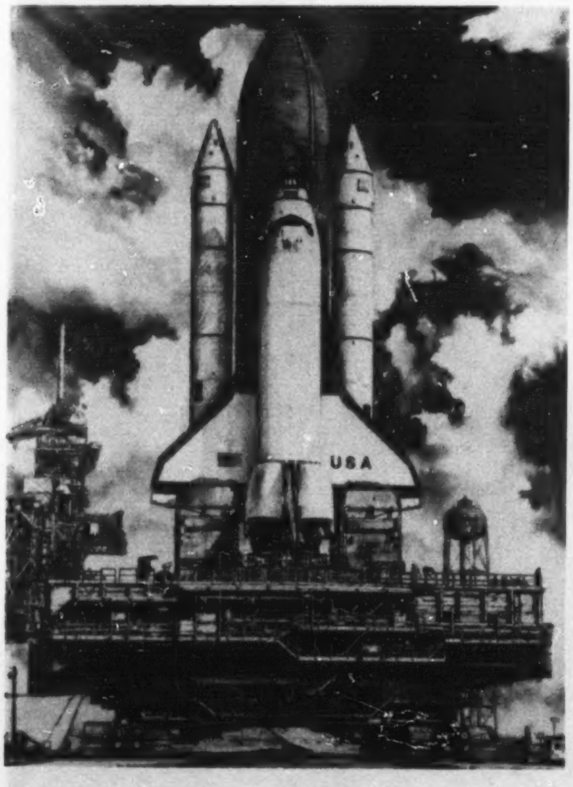
About the Cover

"Coming In," a new NASA watercolor by artist Arthur Shilstone showing a dramatic view of the Columbia as it touches down on the dry-lake bed of the desert after its second flight into space. This new work and the one below are part of a special collection of Space Shuttle art which will be featured at the National Air and Space Museum for approximately eight months, beginning November 30. An article on this show will appear in the Nov. edition of *NASA Activities*. Below is "On the Crawler," a sepia ink sketch drawing with wash on board by artist Chet Jezierski, showing a ground-level view of the fourth Space Shuttle mission rollout.



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Administrator's Column

(In this column *NASA Activities* features an article by NASA Administrator James M. Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees.)

Should NASA Fly Private Citizens Aboard the Space Shuttle?

Man's interest in space has always included the desire to travel, explore and understand its vast horizons. NASA has always believed in an open program and has gone to great efforts to keep people informed. Through such media as on-board television, people have traveled into space vicariously. Now a new opportunity is emerging—for people to go themselves, to see for themselves and to share with others. It has long been a desire of NASA to allow private citizens to fly. Now with the United States in possession of the Space Shuttle and with access to space becoming routine, the opportunity for private citizens to fly as passengers deserves careful consideration. This means that the many interrelated questions must be examined before any agency decision can be made. Therefore, I've asked a small task force of our NASA Advisory Council to study these questions and evaluate the options for selecting passengers. I encourage you to help them with their work.

The maximum current Shuttle capacity is seven people for seven days, which would include a standard crew of four: commander, pilot, and two mission specialists. These crew members are and will be NASA astronauts (with the exception of one individual under a European Space Agency/NASA mission specialist training agreement).

The remaining three slots, if not filled by NASA or user-community trained payload specialists, could provide an opportunity for one or more private citizens to travel aboard the Space Shuttle. The requirements they would have to meet would not be as rigorous as those for astronauts.

A diverse range of people have already expressed an interest in flying as passengers: the news media and such correspondents as Walter Cronkite and Jules Bergman, entertainers such as John Denver and the Rolling Stones, film companies, authors, artists, public figures, futurists and the man or woman who is simply determined to go. We can assume that there are many people that we have not heard from yet.

The total number of citizens interested in flying aboard the Shuttle cannot yet be estimated. But one can assume that the figure would be a large one. So the current challenge before the task force is to determine what kind of criteria to apply to pick the relatively small number of private passengers that can be flown. To give you some sense of the enormous size of such a recruitment/selection task, there were almost 3,500 applicants in 1980 who met the rigorous *minimum* qualifications for 19 astronaut openings.

John Naugle, formerly our chief scientist, is heading the group to study the questions raised in selecting private citizens for flight. He contributed to the development of the mission and payload specialist concepts. The members of the task force bring a spectrum of diverse perspectives and expertise to this task: Capt. Richard H. Truly, pilot of the second Space Shuttle mission; Daniel Fink, formerly General Electric's vice president for corporate planning; Sylvia Fries, historian; Willis Hawkins, chairman of the Aerospace Safety Advisory Panel that oversees the Shuttle program; James Michener, an author who has spent a good deal of time understanding NASA and its history; Julian Scheer, who headed public affairs during the early days when NASA's open policy was developed; and Florence Skelly, president of a major marketing research firm noted for its understanding of the American people, their values, expectations and perceptions.

The task force has adopted a working assumption that: (1) there will be a policy of continuing flight opportunities for private citizens; and (2) NASA needs to establish a "fair" policy and selection process that assures a range of passengers who would bring the fullest benefits to the public. And they're looking at the following kinds of questions in trying to determine a selection process that is perceived as "fair":

- What should the objectives for flying private citizen passengers be? What should their flight role be?
- Should they be integrated into the overall mission and be given tasks to perform or fly aboard strictly as observers?
- What would the benefits to the American people or the world at large be if private citizens are flown aboard the Shuttle? Should consideration be given to selecting not only citizens from the United States but from foreign countries as well?
- How do you determine who gets priority in flying?
- What are the medical and training requirements that would be necessary for private citizen flight roles?

The first meeting of the task force was devoted to identifying such questions. Now the group is fact finding with meetings scheduled for NASA's Johnson Space Center, Houston, in October and Kennedy Space Center, Florida, in November. In addition, the group will contact a small number of people around the country who might have data or insights to share. They plan to have their report to me sometime in late winter.

The questions of flying private citizens aboard the Space Shuttle is clearly a complex one. However, when we find the answers that make it possible to fly passengers, these passengers will be taking another significant step for mankind. Clearly they will set a dual historical first: in the mode of conveyance, the Space Shuttle; and in their destination, the reaches of space.

Improved Outlook for Merit Pay

Since my column in the June edition of *NASA Activities*, significant changes have been made in NASA's merit pay system that I would like to update for you. Previously I stated that although funding for merit pay in 1982 would be twice the 1981 level, it was not an effective incentive system for the agency. I indicated that NASA was pursuing an appeal for exclusion from the merit pay law. Subsequent high level discussions have been held between NASA and Office of Personnel Management officials on equitable pay systems between supervisors and nonsupervisors for a research and development work force.

These discussions have resulted in a new flexibility being made available to NASA which allows us to achieve this objective without the long wait for remedial action through legislative changes or by agency exclusion under the Civil Service Reform Act. NASA is now able to determine the dollar amounts awarded to the various merit pay performance ratings; previously these amounts were controlled by the Office of Personnel Management.

Because it appears this policy revision should meet our primary goal of pay increases on a par with the General Schedule, I will not request agency exclusion from the merit pay system at this time. However, I will continue to closely monitor NASA's experience under merit pay until I am satisfied that this system provides an effective incentive plan for the 3,000 management officials and supervisors affected by this system.

NASA
United States

Pre-Launch Move—Rollover (top photo) of Space Shuttle Columbia on Sept. 9 from the Orbiter Processing Facility to the Vehicle Assembly Building at NASA's Kennedy Space Center, Fla.

International Satellite-Aided Search and Rescue Saves Three Lives

Three survivors of a plane crash in Canada were rescued through the use of satellite data which helped pinpoint their location. Signals from an emergency transmitter from a downed Cessna 172 in British Columbia were received by a Soviet satellite, COSPAS I (Cosmos 1383), designed specifically for search and rescue work. The information was immediately relayed to Canadian search and rescue units. Satellite location of the crash site was only 22.5 kilometers (13.9 miles) of the downed plane. The timely rescue of the crash victims would have been impossible without the satellite data, according to Canadian authorities.

The COSPAS I satellite is one element of an international cooperative project currently in progress between the United States, Canada, France and the Soviet Union to use low-Earth orbiting unmanned satellites to detect and locate aircraft and ships in distress. Such a network provides greater opportunities to save more lives throughout the world.

In July 1982, the Canadian government conducted a massive but unsuccessful search for a pilot lost in northern British Columbia. The search was estimated to cost $2 million before it was terminated. The father of the missing pilot continued the search using his own resources.

The father, a pilot, and one other passenger failed to return from one of their scouting trips on Sept. 9. The Canadian Rescue Coordination Center at Victoria, British Columbia, was notified that the flyers were missing but that no information was available on their possible whereabouts.

The Center was aware of Canada's participation in an international search and rescue project which had included since its June 30 launch, an orbiting Soviet satellite, COSPAS I (Cosmos 1383). The Rescue Coordination Center called the network ground station for this project at Ottawa to determine if any satellite data would be available to aid in locating the missing party. Satellite passes over that area of British Columbia were expected on Sept. 10, the day after the Cessna and its passengers disappeared.

Data from the COSPAS I satellite pass over the area were processed and an emergency locator transmitter location in British Columbia was detected. A search aircraft was dispatched to the predicted location and almost immediately detected the distress beacon on its radio direction finder; the crash site was soon located. The three missing passengers had survived the plane crash but had been seriously injured. They were evacuated by emergency medical helicopters. The cost of the search was minimal.

Operational checkout of the search and rescue satellite-aided tracking (SARSAT) system with the COSPAS system began Sept. 1 to evaluate the combined system's effectiveness in locating distressed aircraft and ships. This demonstration and evaluation phase is expected to last a minimum of 15 months. The Canadian rescue effort is the first direct application of the satellite network to an actual search and rescue operation and validated the effectiveness of the concept.

A national search and rescue plan adopted by Congress in Sept. 1969 mandated that NASA would use aerospace technology to help develop a system of locating aircraft or ships in distress. In 1970 Congress passed a law requiring general aviation aircraft to carry an emergency locator transmitter (ELT) that would emit a signal automatically under stress of an accident. In 1972 the U.S. National Transportation Safety Board recommended that the Coast Guard and Federal Communications Commission require ocean-going vessels carry an emergency position-indicating radio beacon that could be activated either manually or by immersion in water.

These small, lightweight, shock-resistant self-energizing beacons, broadcasting at 121.5 and 243 Megahertz, and in the future, 406 Megahertz (a new frequency under test), are capable of 48 hours of continuous broadcast. These frequencies are reserved worldwide for aeronautical and maritime distress calls. More than a quarter million ships and planes are equipped with emergency transmitter devices.

For such transmitters to be successful, however, the signals must be received and monitored. The International Civil Aviation Organization regulations require that aircraft making long flights over water monitor for transmissions from ocean-going vessels. No

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SARSAT
КОСПАС

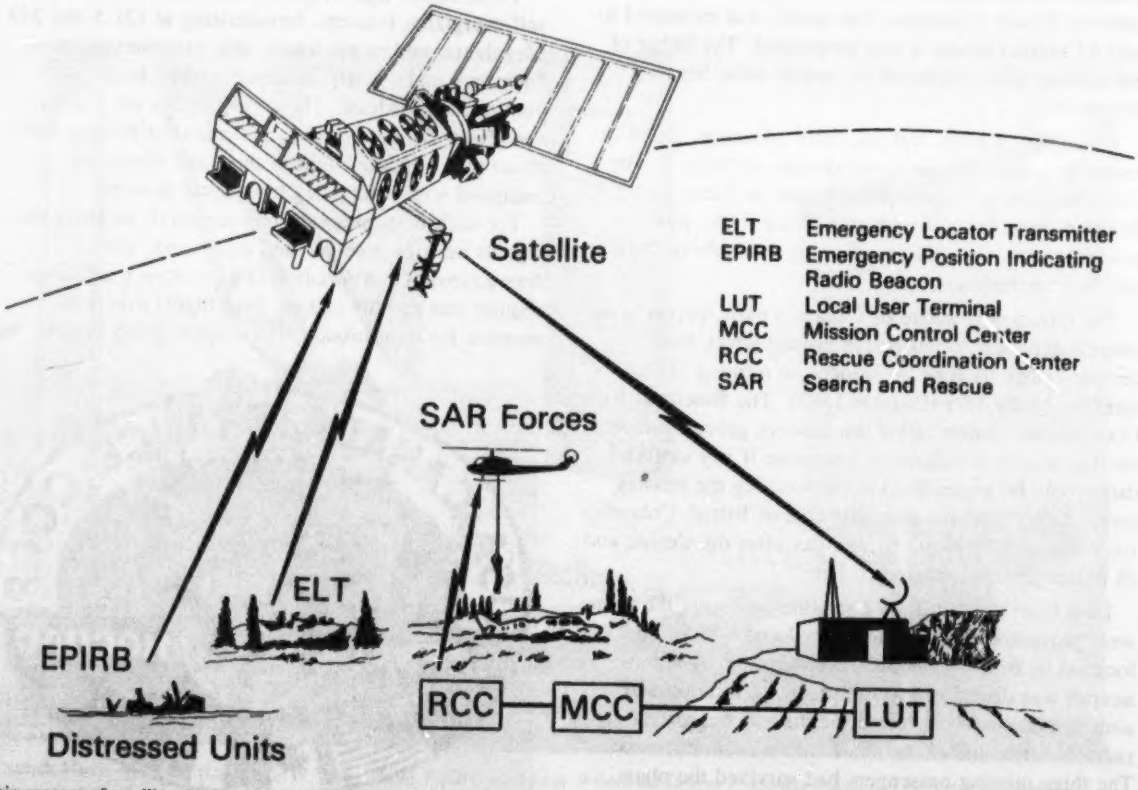
similar monitoring regulations govern flight over land; moreover, even if a passing aircraft has its distress radio turned on, it can only detect these emergency transmitters if it is flying in a direct line of sight with no obstructions. Unless the aircraft is within about 300 km (186.4 mi.) of the distress location, there is little chance of detection.

The use of satellites greatly improves this detection capability. As a low-orbiting satellite passes over these emergency transmitters, it perceives a Doppler shift (change in frequency): a higher frequency when the satellite approaches the transmitter, a frequency that remains identical when the spacecraft is directly overhead, and a lower frequency when the satellite leaves the transmitter. These Doppler data are recovered as an S-shaped curve of frequency versus time. The shape and slope of the curve, together with the location of the satellite at each point of the Doppler curve, are used to locate the emergency transmitter site.

Because a low altitude satellite passing over the North and South poles travels the entire Earth in a 24-hour period, an operational search and rescue satellite-aided tracking system, comprised of three or four satellites, could detect a distress signal anywhere on Earth within a few hours.

In 1976, the Canadian Department of Communication joined the United States to define a joint satellite-aided search and rescue demonstration program called SARSAT (for search and rescue satellite-aided tracking). This joint program was expanded into a trilateral program in Dec. 1977 when the French Centre National d'Etudes Spatiales joined the effort. These nations have cooperatively agreed to build the necessary spacecraft and ground equipment needed to receive and process signals from satellites designed specially for search and rescue as well as maintain search and rescue forces.

Norway (with Swedish participation) and the United Kingdom also have joined SARSAT as "investigators"; other nations are also considering participation in this role. These nations will contribute receiver antennas, ground stations, and user agency rescue efforts, but unlike the United States, Canada, France and the Soviet Union, will not develop or build their own satellites or the necessary spacecraft instrumentation to receive and transmit distress data.


Satellite
ELT Emergency Locator Transmitter
EPIRB Emergency Position Indicating Radio Beacon
LUT Local User Terminal
MCC Mission Control Center
RCC Rescue Coordination Center
SAR Search and Rescue
SAR Forces
ELT
EPIRB
RCC
MCC
LUT
Distressed Units

Basic concept of satellite-aided search and rescue.

The SARSAT project is comprised of both space and ground segments. The space segment involves two "guest" instruments aboard three spacecraft of the National Oceanic and Atmospheric Administration's advanced TIROS-N (ATN) satellite series. The first SARSAT-equipped satellite developed by the United States, Canada and France, called NOAA-E, is expected to be launched in February 1983. While in space, SARSAT equipment will be operated by NOAA.

The SARSAT repeater, one of the "guest" instruments provided by Canada will relay distress messages from emergency transmitters now in use directly to Earth, providing real-time coverage. The second "guest" instrument is a signal data processor provided by France.

As part of the SARSAT ground segment, the United States will install, operate and maintain the U.S. Mission Control Center and three ground stations. The ground stations receive the signal directly from the satellite and process the Doppler information to provide the location of the distress signal.

The U.S. Air Force will operate the U.S. Mission Control Center and one ground station, which are located at Scott Air Force Base, Illinois.

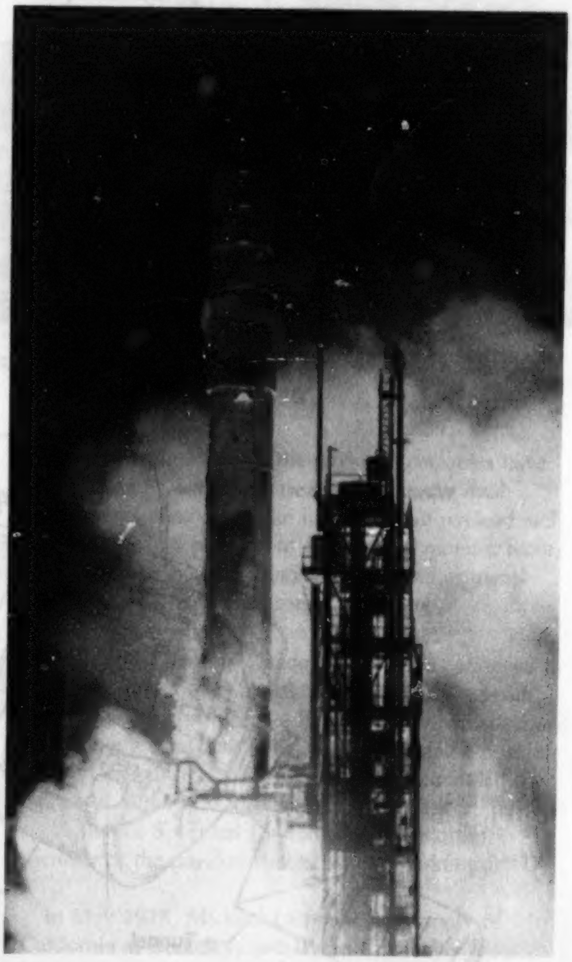
The U.S. Coast Guard will operate the two other ground stations, one at Point Reyes, Calif., and one at Kodiak, Alaska. The U.S. ground stations will provide regional coverage of the 48 contiguous states, Alaska, part of Canada, Mexico, and coastal maritime areas. A Canadian ground station, in Ottawa, will extend this coverage to the eastern North American continent. A French ground station in Toulouse, France, will provide coverage of France and much of Europe and its coastal areas.

Parallel to the SARSAT project is the Soviet Union's compatible search and rescue satellite program, COSPAS. In a 1980 agreement, the Soviet Ministry of Merchant Marine was designated to coordinate its program with the SARSAT program.

COSPAS will fly receivers on Soviet satellites and coordinate its launches with those of the National Oceanic and Atmospheric Administration to provide complete world coverage. The compatibility between these two projects allows the SARSAT ground stations to use the COSPAS satellite when it is in view and vice versa.

Ground stations at Moscow, Archangelsk and Vladivostok will track both SARSAT and COSPAS satellites. The Soviet Union will maintain communications with SARSAT nations through the U.S. Mission Control Center.

On Sept. 29, NASA's Goddard Space Flight Center, Greenbelt, Md., conducted a successful demonstration test of the COSPAS/SARSAT project. As COSPAS I flew within range of Goddard, two emergency transmitting devices were beaming distress signals. On the spacecraft's orbital pass, coordinate information for the signals was relayed pinpointing their location. This data was processed at Goddard; if these beacons had been an actual plane or ship in distress, a rescue effort would have been dispatched immediately. U.S. participation in the COSPAS/SARSAT project is managed by the Communications Division of NASA's Office of Space Science and Applications; technical implementation of the project is under the direction of NASA's Goddard Space Flight Center, Greenbelt, Md.



September's Launch—Successful liftoff of Intelsat V-E on Sept. 28 from Eastern Space and Missile Center, Fla., aboard an Atlas Centaur launch vehicle. Liftoff time was 7:08 p.m. EDT.

Spacelab 1 Flight and Back Up Payload Specialists Named

NASA and the European Space Agency (ESA) have named their prime and back-up payload specialists for the first Spacelab mission, SL-1, scheduled for launch on Sept. 30, 1983, on the ninth Space Shuttle mission.

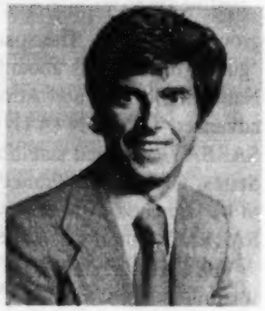
NASA has assigned Byron K. Lichtenberg, a biomedical engineer, and ESA has assigned Ulf Merbold, a West German physicist, as onboard payload specialists. The second American, Michael Lampton, a physicist, and the second European, Wubbo J. Ockels, a Dutch physicist, will act as flight back-ups and will be deeply involved with payload operations from the ground throughout the duration of the mission.

All four men have been in training for the Spacelab 1 mission for the past four years. A laboratory module and one pallet will be used for this mission. Other configurations of Spacelab units can be used for future missions.

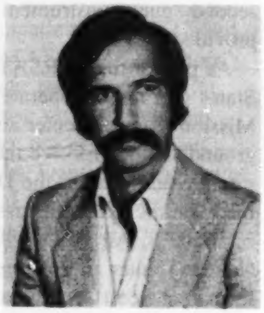
The full crew for the ninth Space Shuttle mission consists of Ulf Merbold and Byron Lichtenberg, payload specialists; Owen Garriott and Bob Parker, mission specialists; and John Young and Brewster Shaw, commander and pilot respectively. Orbiter vehicle will be the Challenger.

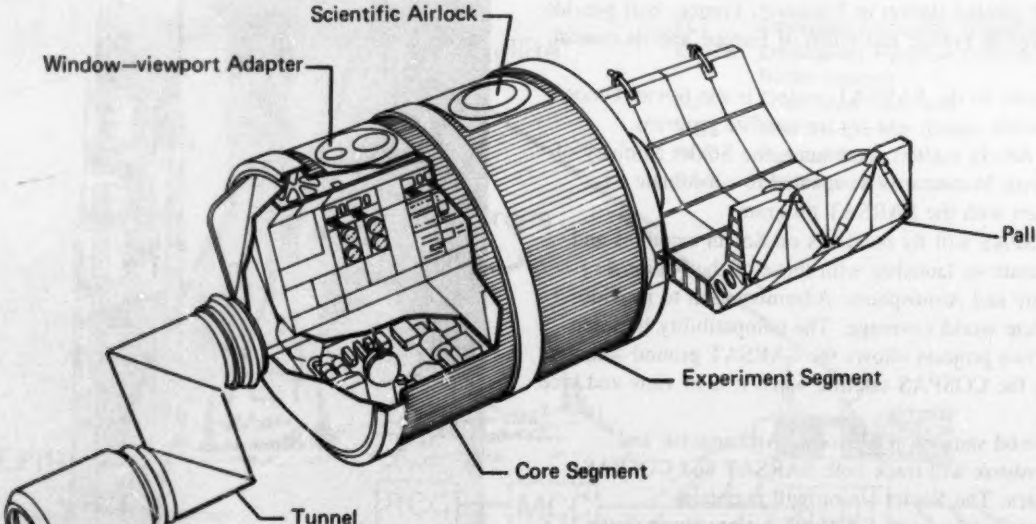
Merbold and Lichtenberg will perform experiments aboard Spacelab using 38 different scientific packages (experiments and experiment facilities) both inside the habitable module and on the pallet. In this role, they will represent more than 70 different scientific investigators from Europe, Japan, and the United States.

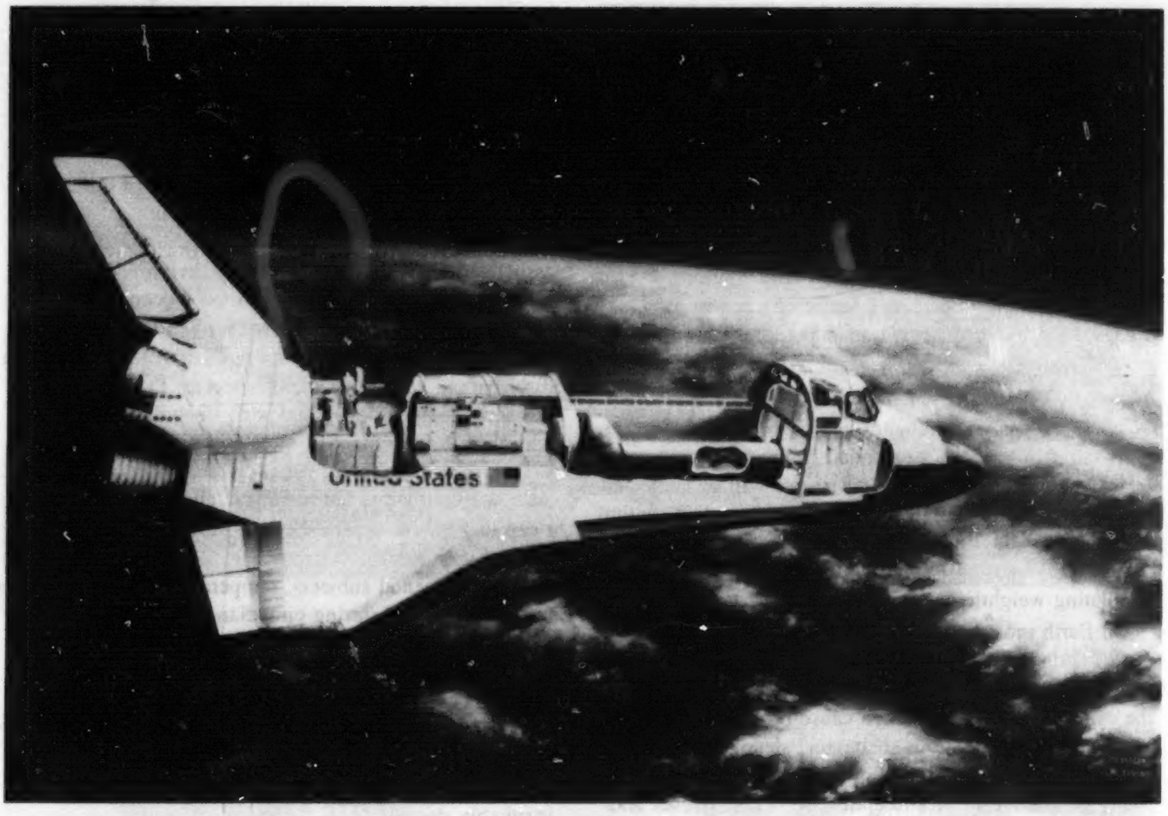
Byron K. Lichtenberg


Ulf Merbold

Michael Lampton


Wubbo J. Ockels





Spacelab 1 configuration (opposite page) consisting of one laboratory module and one pallet. Top photo shows artist's concept of Spacelab 1 aboard the Space Shuttle.

The Spacelab 1 mission experiments were developed by scientific institutes in the ESA member states—Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom—and in Japan and the United States.

Since January 1982, the payload specialists have been undergoing mission operational training in the Payload Crew Training Facility at the NASA Marshall Space Flight Center, Huntsville, Ala., where they are faced with operational situations very similar to those they will encounter during the Spacelab-1 flight. They are, in this way, gaining considerable experience before the launch, thus ensuring a maximum scientific return from the flight.

In December 1977, ESA selected Ulf Merbold, Germany, Claude Nicollier, Switzerland, and Wubbo Ockels, the Netherlands, as payload specialist candidates from among some 2,000 European applicants. Since January 1978, they have been preparing for the Spacelab 1 mission. During their training, which has been carried out in Europe, Japan and in the United States, the payload specialists have acquired an in-depth knowledge of the individual experiments comprising the first Spacelab payload and will thus be in a position to operate and monitor them closely and to execute minor repairs or adjustments which may be required during the flight.

During this period, Claude Nicollier was assigned to undertake mission specialist training and, as a result, was no longer considered a European payload specialist. He is now a candidate for a mission specialist position on the German Spacelab mission, D-1, scheduled for launch in mid-1985. Moreover, ESA's back-up payload specialist for Spacelab 1 automatically becomes a member of the payload specialist team training for D-1.

In May 1978, Michael Lampton, University of California at Berkeley, and Byron Lichtenberg, Massachusetts Institute of Technology, Cambridge, were selected by the Spacelab 1 Investigators Working Group (IWG), to be the American payload specialists.

Human Rhythm Cycles Studied by NASA Scientists

The conditions of space flight—weightlessness, rapid shifts in light/dark cues and social isolation—have been found to disrupt the body's circadian (24-hour) rhythm cycles. Understanding the effects of these conditions is important because such conditions on Earth have been associated with boredom, irritability, negative moods and withdrawal. Upsetting of daily body rhythms also may cause fatigue, decreased performance, insomnia, anxiety, gastrointestinal and other physical symptoms.

Scientists at NASA's Ames Research Center, Mountain View, Calif., led by physiologist Dr. Charles Winget, are studying human rhythm cycles in preparation for NASA's extended Space Shuttle missions where small groups of people will be subjected to these conditions. Winget has studied circadian rhythm in groups placed in social isolation, in shift workers and in humans subjected to prolonged bedrest (a means of simulating weightlessness on Earth.)

On Earth most humans maintain a basic 24-hour cycle, undisturbed until a crossing of time zones (jet lag), an alteration of work hours or a late night disrupts the cycle. Upset rhythms then cause problems with physical health, emotions, behavior, sleep, altered responses to medication and decreased performance. Many people are more susceptible to colds, viruses and infections when their rhythms are disrupted and headaches and intestinal disturbances are more common.

Daily rhythms are linked to the light/dark cycle of Earth, which sets these internal rhythms. Rhythms appear to be a natural function of cell-formation cycles in the body; cancer cells are the type that do not exhibit rhythms.

Pulse rate, blood pressure, heart rate, temperature, kidney function, metabolism and hormone secretions all follow a pattern and rhythm. The first three are lower at night. Temperature is low in the early morning and high in the late afternoon; most people perform best when their temperature is highest, usually about 3 p.m. Kidney function is high during the day and low at night. Metabolic activity is highest at noon. Adrenal rhythms vary, but are higher during early sleeping hours.

Drugs and alcohol affect the body differently at various times of day. The same amount of alcohol taken early in the morning will result in a higher blood-alcohol level than if taken at about 4 to 5 p.m.—the optimal time for alcohol consumption. Medications, like alcohol, vary in their effect depending on the time of day administered. An oral dose of antihistamine given at 7 a.m. will last 15 to 17 hours, but given at 7 p.m. will last just six to eight hours. Digitalis (a heart medication) has twice the effect when given at night. Drugs can be given in lower doses if properly timed—especially important for powerful cancer medicines with strong side effects. A new field of biology, called chronopharmacology, was developed by Winget and others to study the effects of drugs administered at different times of the day.

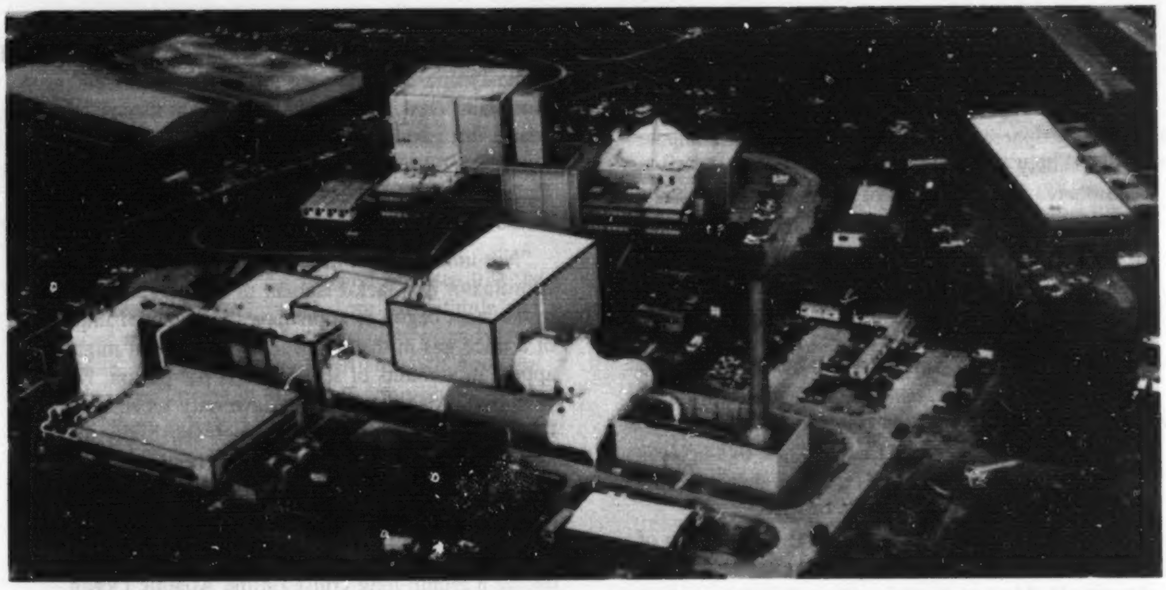
Emotional and psychiatric disorders are also associated with upsets in circadian rhythm. Experimental subjects have reported a deep sense of depression and hopelessness within 72 hours of a shift in circadian patterns. Most individuals react to circadian disturbances with lowered self-esteem. Psychological problems may be associated with sleep difficulties, which are a side-effect of circadian disturbance. When sleep stages are altered, the individual may sleep for an adequate number of hours but the altered rhythm of sleep leaves him unrefreshed, listless and vaguely uncomfortable.

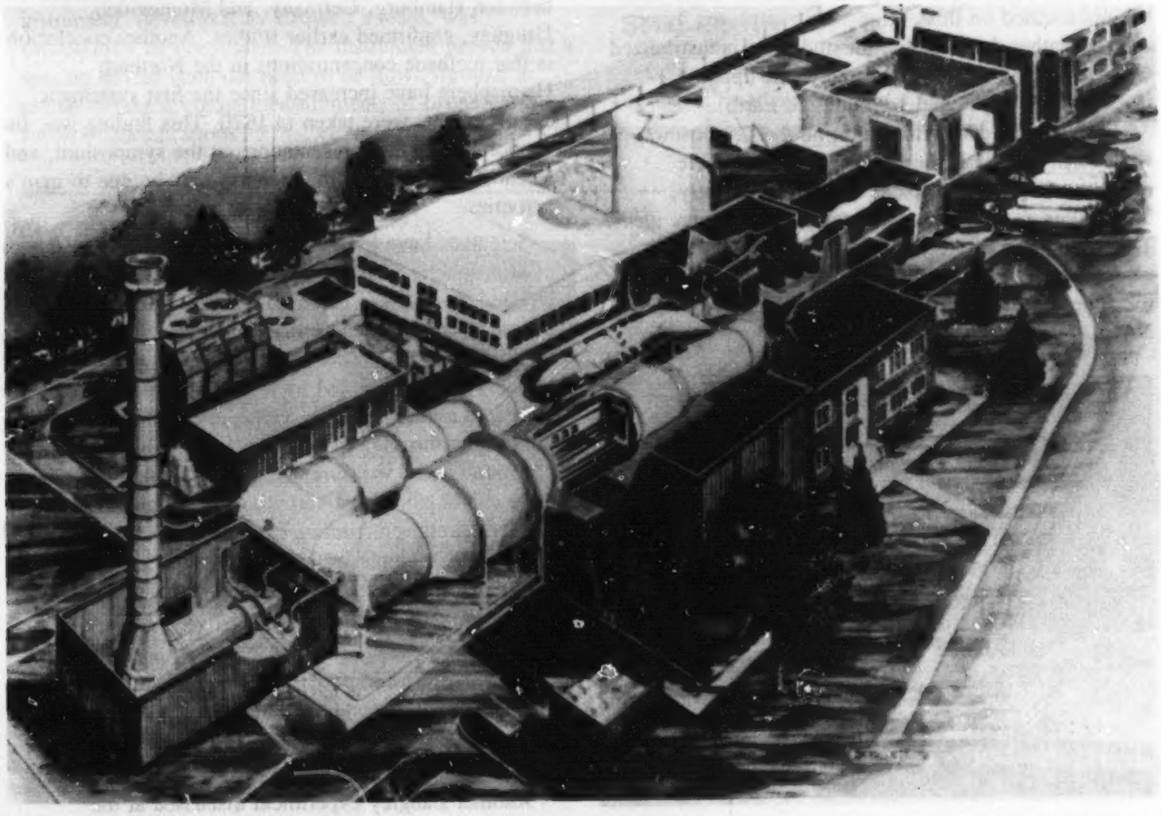
In experimental subjects, temperature and brain waves became abnormal during circadian disruptions and neither measure returned to normal in less than two weeks. Winget concludes from these and other findings that work schedules should not be shifted more often than every three weeks. Otherwise the worker is continuously deprived of normal, health-giving sleep patterns, and performance and safety awareness inevitably decrease.

Studies of humans isolated in small groups have shown that social interaction affects rhythm. Rhythms for individuals in a small group tend to synchronize together and change when new individuals are introduced into the group.

Winget recommends the following guidelines for coping with an upset circadian rhythm:

- Perform the most important tasks as soon after waking as possible.
- Avoid working with power tools or driving a vehicle when feeling sleepy or disoriented.
- Eat the largest meal of the day as soon as possible after waking.
- Decrease caloric intake slightly and avoid overloading the system with food.
- Decrease intake of salt, coffee, beer, wine and hard liquor. Caffeine can help increase performance, but only when taken at peak times—such as the high point in the temperature cycle.
- Use only prescribed medications. Amphetamines and sleeping pills won't help, because of their "hangover" effect and because they disturb "REM"—Rapid Eye Movement—sleep (dreaming), which is important to human psychological well-being.





NASA's Newest Wind Tunnel—Nearing completion is the National Transonic Facility, a cryogenic wind tunnel at NASA's Langley Research Center, Hampton, Va., designed to test aircraft in the high pressures of transonic flight. Calibration checkouts of the tunnel are scheduled to begin in January 1983 with full-scale operation to follow a few months later. The facility will be shared equally between NASA and the Department of Defense. Bottom photo shows artist cutaway view of the facility.

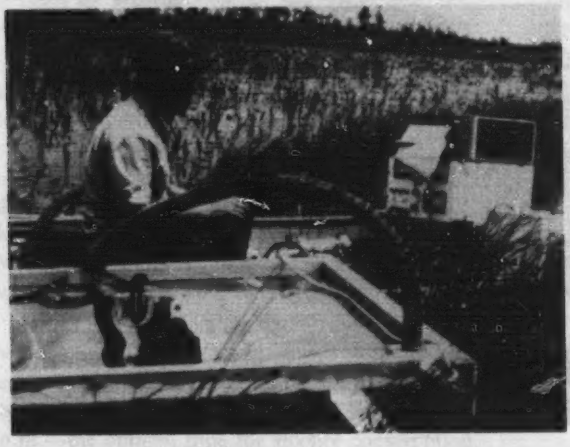
Scientists Find "Clean" Air Is Not So Clean

Fresh farm, mountain, and ocean air may not be as clean as once thought. This air is part of the Earth's lower atmosphere—the troposphere—which composes approximately 80 percent of the planet's total atmosphere. Recent studies of trace gases in this region have revealed relatively high concentrations of carbon monoxide, ozone, and aerosol particles, all pollutants.

Also, scientists suspect other trace gases in this region, particularly methane and ozone, could affect the region's atmospheric chemistry and possibly reduce the amount of heat the Earth radiates back into space—a process which, in turn, contributes to global warming. In addition, man's activities may impact the composition of this region. Methane, for example, is produced both naturally and as a by-product of man's activities.

Relatively little is known about the composition of the troposphere, how it evolved or how man may be changing it. Most research on atmospheric composition has not focused on this region where airplanes fly or where weather develops but on studies of industrialized urban areas and on the stratosphere (the upper 20 percent of the gases that surround the Earth).

However, a recent symposium on the composition of what researchers call the "non-urban troposphere" brought nearly 200 representatives from industry, universities and government together to exchange ideas. The symposium, held at Williamsburg, Va., was co-sponsored by the American Meteorological Society, the American Geophysical Union, and NASA. Nearby NASA Langley Research Center, Hampton, Va., contributed more than 10 percent of the 112 technical presentations. Other NASA installations that contributed to the symposium were the Ames Research Center, Mountain View, Calif.; Wallops Flight Center, Wallops Island, Va.; and Goddard Space Flight Center, Greenbelt, Md. The Langley presentations included new findings about three environmentally significant gases: methane, carbon monoxide and ozone.



NASA Langley's Dan Sebacher makes a methane flux measurement in the Okefonokee Swamp in Georgia. Production of the gas was found to vary greatly from one wetland area to another and even within a single wetland area.

"Not until the past decade," said symposium coordinator Dr. Jack Fishman of Langley, "have researchers begun to appreciate the potential importance of a trace gas in the troposphere (a gas that might appear in amounts of several parts per billion, for example). Also, researchers have only recently developed instruments with enough sensitivity to accurately measure certain gases in trace amounts."

Randy Cofer of Langley's Field Experiments Branch reported the presence of more methane in the Northern Hemisphere than the Southern Hemisphere. Data taken during a month-long cruise on the Atlantic Ocean between Hamburg, Germany, and Montevideo, Uruguay, confirmed earlier studies. Another conclusion is that methane concentrations in the Northern Hemisphere have increased since the first systematic measurements were taken in 1970. This finding was also supported by other presentations at the symposium, and scientists suspect that the increase may be due to man's activities.

Scientists have long assumed that the primary sources of atmospheric methane are natural, coming from wetland areas (swamps and marshes) and, to a lesser degree, from cows and other ruminant animals that give off the gas in the process of digestion. A group of Langley researchers, led by Dr. Robert Marrias, presented evidence at the symposium that may cause thinking in this area to be reevaluated. Through a series of ground-based measurements, they found two things: there can be enormous variation in the amounts of methane produced from one wetland area to another and even within a single wetland area, and wetlands may contribute much less of the global methane than was previously estimated.

These results, vigorously debated at the meeting, documented the complexity of the ecosystem in which methane is naturally produced and suggest that man's activities may disturb the natural methane cycle much more than was previously thought.

Another Langley experiment discussed at the symposium concerned measurements of atmospheric carbon monoxide, ozone, other trace gases and aerosols (tiny particles suspended in the air). The measurements were taken from an airplane flown off the East Coast of the United States in the summer of 1981. An orbiting satellite had identified a plume of air that originated over the eastern United States extending approximately 2,000 kilometers (about 1,250 miles) over the Atlantic. Researchers flew the airplane into and over the plume. When they flew through the plume, they took direct measurements of carbon monoxide and ozone; when flying over the plume, they used remote sensing devices to measure ozone and aerosol concentrations.

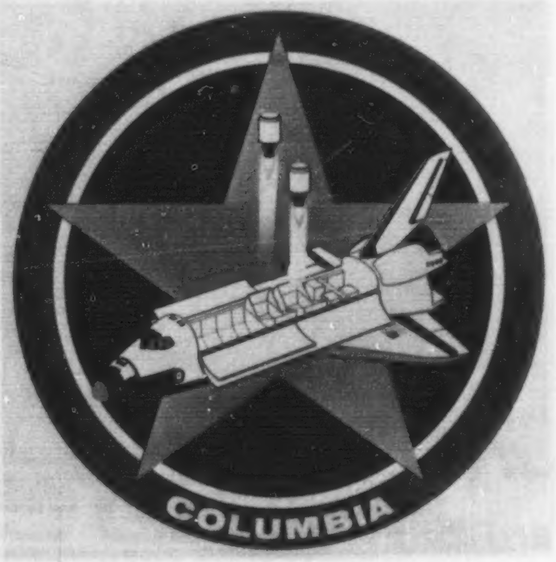
Team spokesman Dr. Ed Browell reported that the plume extended up to 2 km (1.2 mi.) in altitude and contained relatively high concentrations of carbon monoxide, ozone and aerosol particles. All three are considered pollutants in the lower atmosphere. In essence, their close-up look confirmed the location and overall size of the plume as indicated by satellite readings. The satellite instrument, however, is only capable of "seeing" aerosols.

A by-product of the dual set of airplane measurements (through and over the plume) is that the capability of an advanced laser remote sensing instrument, developed by Browell's team, was successfully demonstrated. The instrument proved that a sensing device does not need to be flown through a plume to take accurate measurements of ozone and aerosol concentrations.

In November 1981, a Langley instrument for the remote sensing of carbon monoxide flew aboard the second flight of the Space Shuttle and took the first measurements from space of a trace gas in the lower atmosphere. Results of the experiment—Measurement of Air Pollution from Satellite—were presented for the first time at the symposium. Data quality was exceptional and exceeded all expectations. Dr. Henry Reichle of Langley's Chemistry and Dynamics Branch presented measurements of carbon monoxide from selected orbits. The MAPS instrument literally "mapped" the location of strong gradients of carbon monoxide (where low concentrations meet high concentrations) down to 100-km (60 mi.) areas or less. This high resolution allowed the Shuttle-borne experiment to define relatively small regions of carbon monoxide in elevated concentrations.

Updated Stirling Engine Concept Used As Solar Energy Device

Concentrated sunlight may be the energy source used in the future to supply power to small communities or remote villages not connected to an electric utility grid.



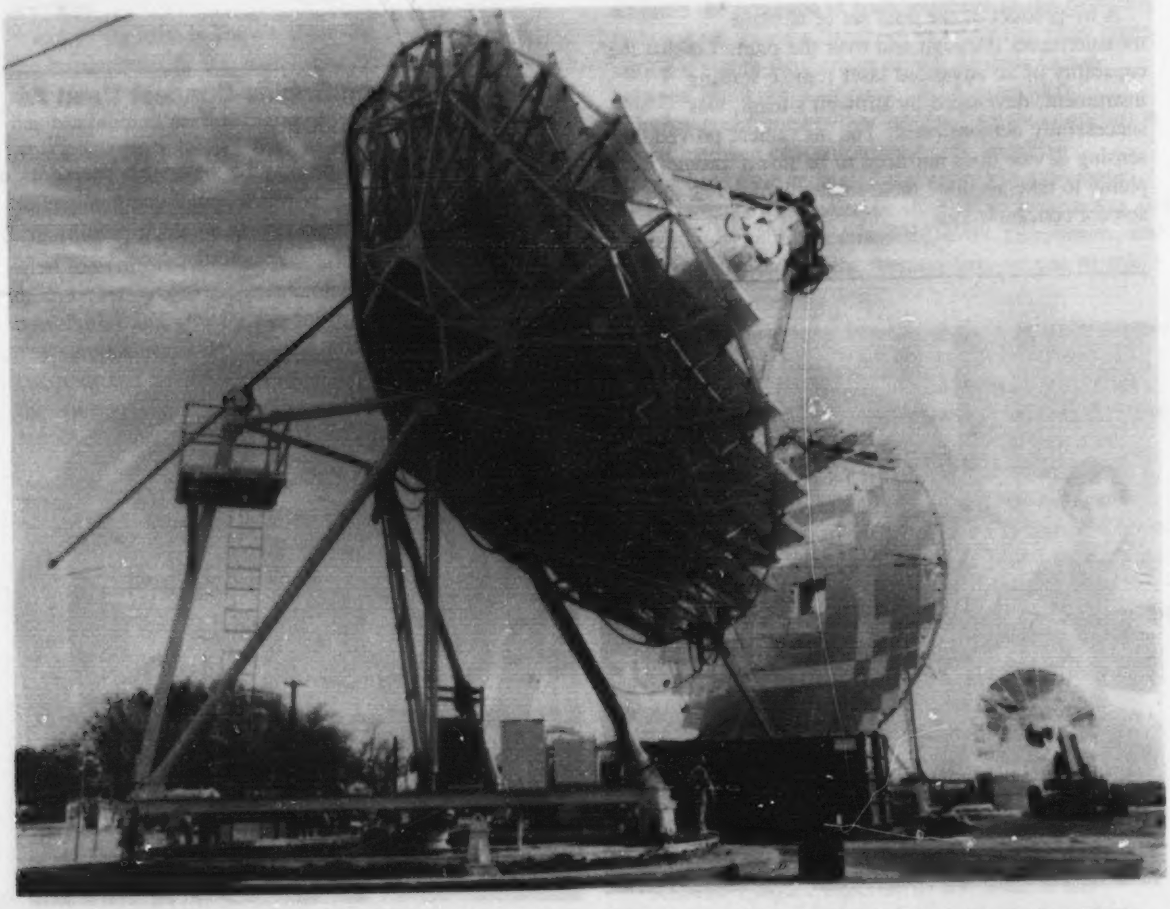
Fifth Space Shuttle Crew and Insignia—Flying aboard the Space Shuttle Columbia for her fifth mission, scheduled for launch Nov. 11, will be a four-member crew. From left to right are: Joseph P. Allen, mission specialist; Vance D. Brand, commander; Robert P. Overmyer, pilot; and William B. Lenoir, mission specialist. Official crew patch for the fifth flight of the Space Shuttle (note five points of star). This mission is the first operational flight following four successful orbital test flights.

A system tested by NASA's Jet Propulsion Laboratory (JPL) engineers in the California desert used solar radiation to drive an engine which, in turn, was used to generate a daily (sunrise to sunset) average of 250 kilowatt hours of electrical energy (enough to power 8-10 average homes). Power from the system was fed into the Southern California Edison utility grid; peak power output measured 23.5 kilowatts.

For this test, JPL engineers combined a technologically updated Stirling engine with a dish-shaped solar collector/concentrator. The Stirling engine, named for its 1816 inventor, Scottish minister Reverend Robert Stirling, is a 166-year-old closed cycle concept that can be powered by any external heat source. The JPL experiment is part of the Department of Energy's program in solar thermal technology.

The parabolic dish/Stirling engine system demonstrated an unusually high level of efficiency—29 percent, a milestone for solar conversion systems. (Efficiency is defined as the system's electrical output divided by the amount of solar energy collected.) Evaluation of solar concentrator dishes combined with a Stirling engine to produce electricity has been under way since 1979 at the JPL test site at Edwards Air Force Base, Calif.

Tests to date have used a test bed solar concentrator designed specifically for experimental research. The 11-meter (36-foot) diameter dish is constructed of 224 individual mirrors mounted on a steel truss framework. Solar radiation striking the mirrors is focused into the aperture of a receiver suspended above the center of the dish. This aperture is 20 centimeters (8 inches) in diameter. The receiver takes this concentrated radiation



Solar energy conversion system which uses concentrated sunlight to drive a Stirling engine. The mirrored parabolic dish focuses the sunlight to drive the engine, suspended in the housing above the dish. The Stirling engine supplies the mechanical power to drive an electric generator. The system fed an average of 250 kilowatt hours of electrical power during the day into the Southern California Edison utility grid from a test site in the California desert.

and converts it into heat at 700 degrees Celsius (1,300 degrees Fahrenheit), which is used to power a Stirling engine. The engine supplies the mechanical power to drive an electric generator.

Testing of the Stirling engine with the test bed concentrator is managed by JPL for the Department of Energy through a contract with NASA. United Stirling, Inc., a U.S. subsidiary of United Stirling of Sweden, designed, adapted and built the engines for use on solar dish concentrators.

In order to carry forward the research on the solar Stirling engine concept, the Department of Energy has a cooperative agreement with Advanco Corp., El Segundo, Calif., to develop a complete parabolic dish/Stirling engine system over the next two years. JPL serves as the technical monitor for this effort managed by the Department of Energy's Albuquerque operations office. This effort includes a new lower-cost concentrator of a design suitable for use in a system that could become a commercial product in the future.

In late 1983, a new parabolic dish/Stirling engine module will be installed and tested at one of Southern California Edison's Palm Springs facilities. According to Dr. L.T. Papay, Edison's Vice President of Advanced Engineering, the utility views solar energy projects, such as the dish/Stirling engine power system, as a keystone in Edison's 10-year commitment to the accelerated development of alternate and renewable energy sources in this decade.

Dr. Vincent Truscello of JPL is the technical manager of dish/electric projects with program management by the Department of Energy's Albuquerque operations office.

Halley's Comet Watch Network Formed

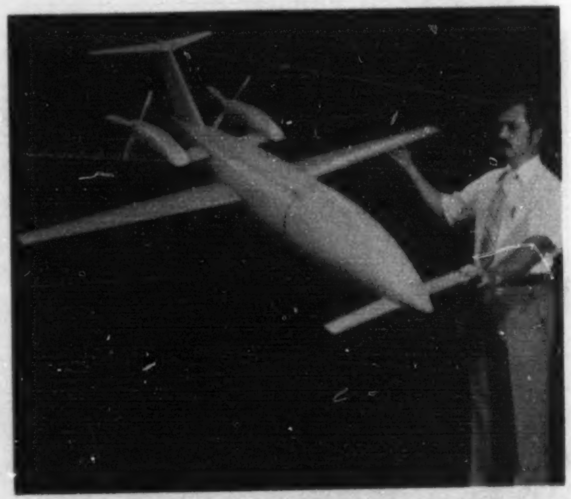
An international network of scientists is being organized to observe Halley's Comet as part of a coordinated program when the comet passes Earth in 1986. The organization, called the International Halley Watch, will be led by Ray Newburn, cometary science team leader at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and Jurgen Rahe, director of Remeis Observatory (Bamberg) of the University of Erlangen-Nurnberg, Erlangen, Federal Republic of Germany. The Watch invites all Halley's Comet observers, professional or amateur, to share their data with the networks now being created.

Ground-based observations along with those of balloon, air borne and earth-orbital instruments will be collected by the International Halley Watch. Data compiled by the Watch will form the Halley Archive, the largest collection of information ever produced on a single comet.

Japan, the Soviet Union and the European Space Agency are each sending spacecraft to encounter the comet in 1986, and plan to supply their scientific results to the Halley Archive.

Experiment teams supported by the International Halley Watch will study the comet using seven general techniques:

- Large-scale phenomena studies will use wide angle photography to study the comet's tails.
- Near-nucleus studies, using high-resolution photographic and electronic imaging of the coma, will yield data on the nucleus, its rotation rate, surface structure and the comet's general activity.
- Spectroscopy and spectrophotometry will provide data on the physical composition of the nucleus, coma and tail.
- Photometry and polarimetry will determine the abundances and distribution of volatile and non-volatile components of the coma and tail.
- Radio science experiments study the chemical composition and kinematics, or motion, of the coma, nucleus and tail, searching for chemical species not



Commuter Aircraft of the Future?—Model being used in wind tunnel tests at NASA's Langley Research Center, Hampton, Va., to investigate stability and control in low-speed flying situations. The concept is called "three surface" because it has a forward canard, main wing and rear horizontal tail. The long, slender main wing is designed to be fuel efficient. The aft-mounted engines do not interfere with the wing lift and the design promises less cabin noise. From its nose-mounted horizontal wings to its rear-mounted twin prop engines this one-seventh scale model represents some of NASA's latest thinking about the shape of things to come in commuter aircraft.

discernable in optical wavelengths. Radio experiments will also detect thermal emissions from solids and perform studies of plasmas.

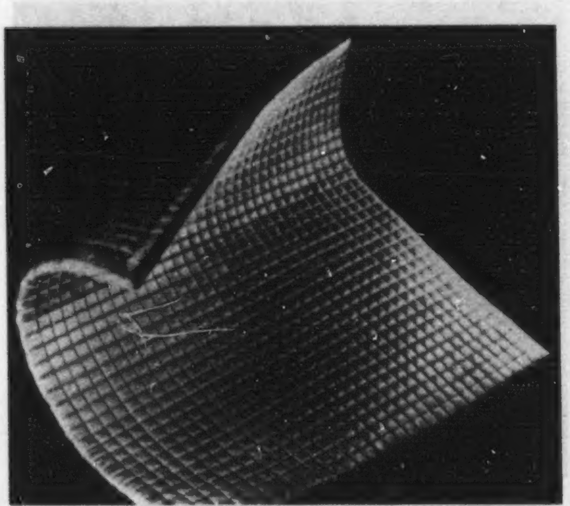
- Infrared spectroscopy and radiometry will determine the temperature, size and composition of dust particles released by the comet. Gaseous components also may be identified.
- Astrometric observations—studies of Halley's position in relation to stars—will provide information on the comet's orbit and ephemeris. The observations will also help determine what effect outgassing of ice from the nucleus has on the comet's velocity.

The efforts of amateur astronomers will be coordinated by the International Halley Watch to complement those of professionals.

Amateur visual and photographic observations will be compared with those of the 1910 apparition of Halley. Spectroscopy and photoelectric photometry of the comet obtained by amateurs can provide supplementary coverage of Halley in cases of weather interference at major observatories.

Amateur studies of meteors during the Halley apparition will be especially helpful, since few professional astronomers devote time to meteor observations. The Eta Aquarid Meteor shower in May 1986 and the Orionid Meteor shower in October in the same year are believed to originate from Halley.

The International Halley Watch office at the Jet Propulsion Laboratory is funded by NASA, and the Bamberg office is supported by the Federal Republic of Germany.



Protective Quilt—Latest in thermal protection material to be added to the Space Shuttle is this silica glass quilt called Advanced Flexible Reusable Surface Insulation developed by NASA's Ames Research Center, Mountain View, Calif., and produced by Manville Building Materials Corp., Denver. This quilt is tougher, lighter and cheaper than earlier tile heat shields. This material, installed over a 20 square-foot area of Columbia's elevon cove, will cover a larger area on Challenger, the second Space Shuttle currently undergoing flight readiness work at NASA's Kennedy Space Center, Fla.

NASA's Electric Rocket Engine to be Tested on Air Force Satellite

A NASA developed solar-powered electric propulsion system may become the satellite auxiliary propulsion system of the future, replacing traditional chemical and gas systems. Lighter in weight than other systems, it can save hundreds of kilograms of weight which could translate into lighter satellites or satellites of the same weight but carrying additional payload such as revenue-producing communications channels. Advantage of the system increases with increasing satellite weight and longer missions.

Pioneered by NASA's Lewis Research Center, Cleveland, the ion auxiliary propulsion system, an electric rocket engine, will be flight tested aboard an Air Force research satellite to evaluate how well it functions in the company of other space hardware. The three-year flight test is designed to qualify the system in space for performing such auxiliary propulsion functions as stationkeeping, attitude control and orbit maneuvering of the spacecraft.

Developed to provide highly fuel-efficient, long-duration, low-thrust propulsion for many applications on space vehicles, the Lewis electric rocket engine recently completed an 11-year-long test in space to verify its durability and operational reliability under space conditions.

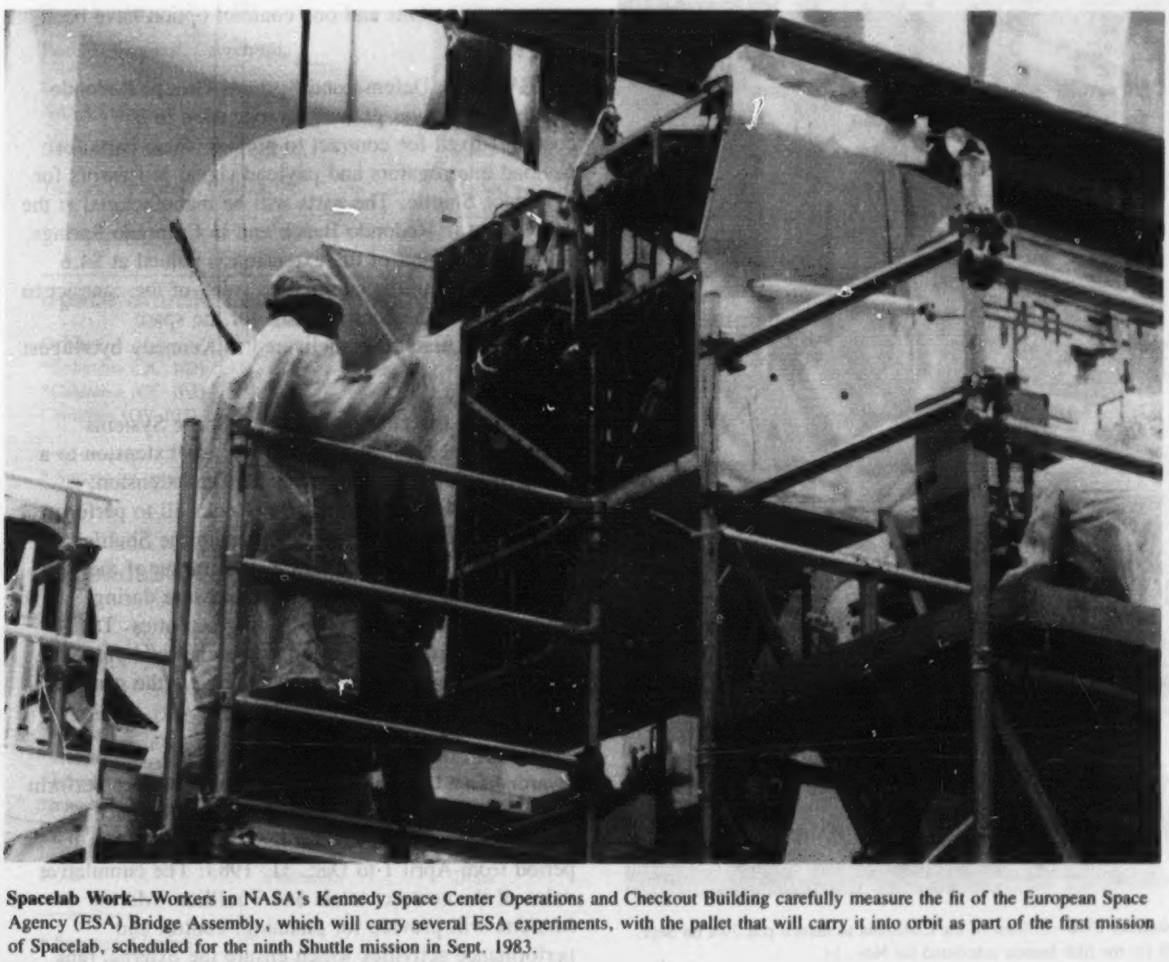
In operation, the mercury ion thrusters of the system are powered by the satellite's solar cells which convert sunlight into electricity for spacecraft power. A power electronics unit converts this spacecraft power into currents and voltages needed to operate the thrusters. With this electric power, mercury atoms in the thruster are bombarded with free electrons producing positively charged mercury ions.

At the aft end of the thruster are two metal screens, with a 1,500V potential drop between them. As the mercury ions pass through the screens, they are accelerated to speeds of 30 km/sec and exhausted along with electrons creating a thrust-producing beam. Some of these exhaust products stray and can come in contact with the satellite's solar array as well as with instruments mounted in the proximity of the system's thruster.

These space tests will determine what effect, if any, this efflux will have on other satellite components. It will also verify that the 8-cm ion auxiliary propulsion system can perform as expected in the role of a satellite stationkeeping device over very long periods of time.

The thrusters are sized to be directly applicable to stationkeeping of communications satellites that weigh about 1,000 kilograms (2,200 pounds) and have seven to 10-year lifetimes. The flight test will duplicate the thruster operation requested for such applications by operating through 2,500 on-off cycles and more than 7,000 hours operation in a 20-month period. Commands from the ground will be initiated at the Lewis Center, relayed to selected Air Force ground stations, and then transmitted to the satellite during its 10-minute passes over ground stations. The two thrusters will be mounted on the satellite in close proximity to a number of diagnostic instruments. The instruments will measure the interactions of the discharge from the thrusters—principally ionized and neutral mercury—with nearby spacecraft elements. The data will make it possible to estimate the magnitude of these interactions with operational space vehicles.

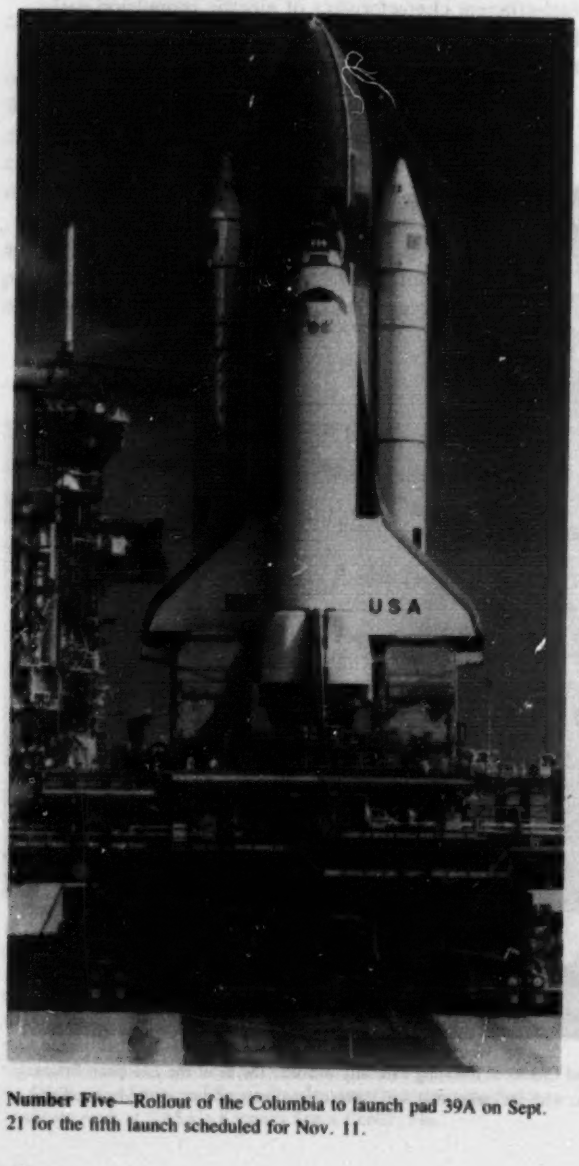
While 8-cm thrusters are suitable for spacecraft stationkeeping applications, 30 cm and larger thrusters, employing the same technology, have been developed and verified in ground tests. These larger thrusters are sized for use in orbit raising, attitude control and maneuvering of large space structures contemplated in future NASA programs. The long-life, low-thrust, fuel-efficient characteristics of electric propulsion make it attractive for controlling and manuevering large, relatively fragile bodies in space.



Spacelab Work—Workers in NASA's Kennedy Space Center Operations and Checkout Building carefully measure the fit of the European Space Agency (ESA) Bridge Assembly, which will carry several ESA experiments, with the pallet that will carry it into orbit as part of the first mission of Spacelab, scheduled for the ninth Shuttle mission in Sept. 1983.

The same characteristics also make electric propulsion attractive for propelling interplanetary payloads in exploration of the solar system. The ion auxiliary propulsion systems' flight test will serve to verify feasibility and readiness of technology elements useful in all these applications.

Hughes Aircraft Co., El Segundo, Calif., built the Ion Auxiliary Propulsion System under contract to Lewis. The Air Force spacecraft contractor is Rockwell International, Seal Beach, Calif.



Number Five—Rollout of the Columbia to launch pad 39A on Sept. 21 for the fifth launch scheduled for Nov. 11.

Contractor News

NASA has awarded a $21 million cost-plus-fixed-fee contract to **United Technologies Corp.,** Power Systems Div., South Windsor, Conn., for development of technology for multi-kilowatt on-site fuel cell power plants. Three specific components of fuel cell power plant technology will be investigated: the fuel processor, the fuel cell stack and the electrical inverter. The initial effort, covering 15 months, will cost $4.2 million. Duration of the contract is for six years. The fuel cell power plants in this program are larger terrestrial versions of the systems used to generate electricity in the nation's manned space program. Multi-megawatt fuel cell systems are also being developed for use by electric utilities for electrical power generation. The contract was awarded under the Department of Energy's Phosphoric Acid Fuel Cell Systems Program managed by NASA's Lewis Research Center, Cleveland.

And from NASA's Kennedy Space Center, Fla., three contract extensions and one contract option have been awarded:

TRW Inc., Defense and Systems Group, Redondo Beach, Calif., was granted an extension to a cost-plus-fixed-fee contract to provide spare parts for payload interrogators and payload signal processors for the Space Shuttle. The parts will be manufactured at the TRW plant in Redondo Beach and in Colorado Springs, Colo. The amount of the extension is valued at $4.6 million, bringing the cumulative value of the contract to $5.8 million. The contract calls for the spare replacement units to be delivered to Kennedy by August 1984.

Rockwell International Corp., Space Systems Group, Kennedy Space Center, Fla., an extension to a Space Shuttle processing contract. The extension, valued at $94.6 million calls for Rockwell to perform normal processing functions to prepare the Shuttle orbiters for launch at Kennedy: preparation of the orbiters, main engines and other hardware during pre-launch, launch and post-landing activities. The cost-plus-award-fee extension brings the total value of the contract to $416.5 million and covers the period from March 31 through Dec. 31, 1982.

Martin Marietta Corp., Denver, Colo, has been awarded an $11.5 million contract extension to perform external tank processing operations for the Space Shuttle. The cost-plus-award-fee extension covers the period from April 1 to Dec. 31, 1983. The cumulative value of the contract totals $54.3 million. Martin Marietta will provide for planning, control and performance activities which ensure the external tank and associated support equipment operate within specifications.

Boeing Services International, Kennedy Space Center, Fla., has been awarded a one-year contract option to provide supply and transportation services to NASA's Kennedy Space Center. This option, in the amount of approximately $12 million, covers Boeing's work until June 30, 1983. Included in this work will be provisioning, acquisition accountability, inventory management, receipt storage and distribution of materials and equipment at Kennedy, and selected activities at Vandenberg Air Force Base, Calif.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Bruce A. Banks, Michael J. Mirtich, and James S. Sovey, NASA/LeRC	Improved surface texturing	4,344,996	LeRC
Lo I Yin, NASA/GSFC	Low intensity X-ray and gamma-ray imaging spectrometer	4,345,153	GSFC
Bruce L. Gary, Caltech/JPL	CAT altitude avoidance system	4,346,595	NRO/JPL
Paul M. Gammell, Caltech/JPL	Improved hyperthermia heating apparatus	4,346,715	NRO/JPL
Leland A. Imig and Mickey R. Gardner, NASA/LaRC	Heating and cooling system	4,346,754	LaRC
David B. Rhodes, NASA/LaRC	Scanning a focal laser velocimeter projection lens system	4,346,990	LaRC
Thomas J. Pivirotto, Caltech/JPL	Method and apparatus for convection control of metallic halide vapor density in a metallic halide laser	4,347,613	NRO/JPL

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OC-102)	March 22	KSC	OSS-1
*Columbia (OC-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-C, Telesat-E

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* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
*Telesat-G (Anik-Da)	August 26	Delta	ESMC	Canada communications. Reimbursable.
*Intelsat V-E	September 28	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
RCA-E	October 28	Delta	ESMC	RCA communications. Reimbursable.
Intelsat V-F	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
IRAS	December	Delta	WSMC	Infrared astronomy, NASA scientific. Reimbursable.

---

* Successful launch

Another Dividend from Air and Space

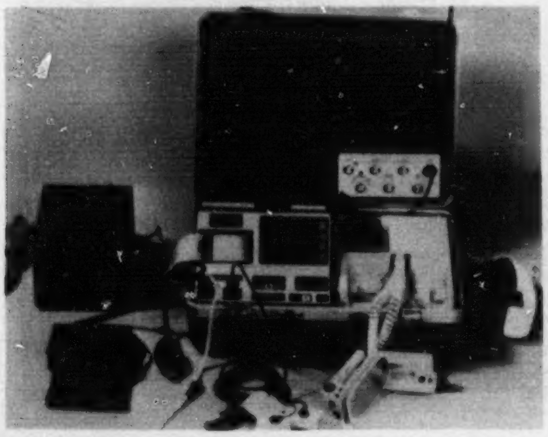
Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Portable Medical System

Emergency medical treatment for heart attack victims in rural or remote areas, particularly important where considerable time may elapse before the patient reaches a hospital, has been made possible through a spinoff of aerospace medical technology. Called a Portable Medical Status and Treatment System,* this life-saving "briefcase" (photo below) displays pulse rate, temperature, blood pressure and respiration rate along with status information including heart rate and respiration alarms. The system also contains a defibrillator which can deliver electric shock in six different levels to restore rhythmic heartbeat.

A 10-channel radio equipped with two-way voice communication and the system's electronic capability of transmitting vital signs to a distantly located physician, allows the attendant at the emergency scene to diagnose and receive treatment instructions. The battery-powered portable medical system can operate up to 6 hours.

The Portable Medical Status and Treatment System was developed from an earlier NASA project known as the Physician's Black Bag, a portable monitoring treatment unit developed for Johnson Space Center by Telecare, Inc., a company later acquired by Narco Scientific, Houston.



First units were delivered to the Department of Transportation last year and tested in two types of medical emergency environments—one in a rural Pennsylvania community and another aboard a U.S. Coast Guard rescue helicopter operating along Florida's Gulf Coast.

Narco also has developed a companion system called Porto-Fib III (photo above) with refined and expanded defibrillating and display functions designed for use in hospitals.

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* NASA does not endorse commercial products as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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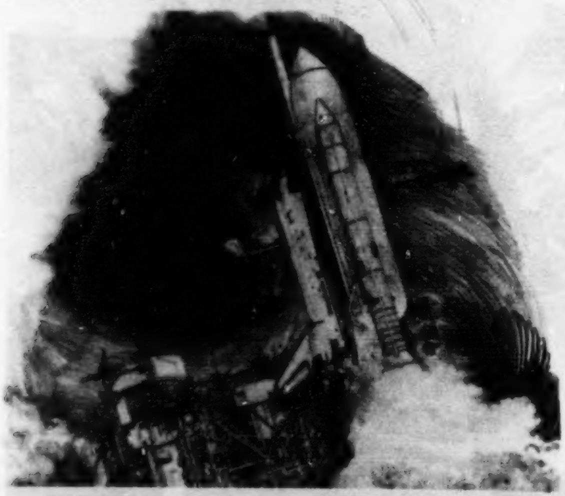
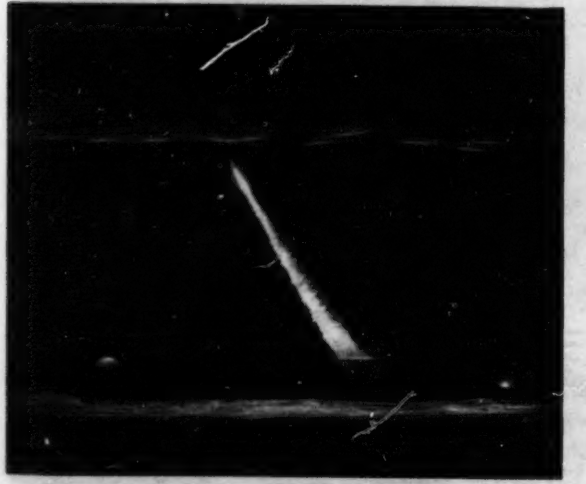
About the Cover

"Thanks for the Memories," a photographic tribute to the pressure suits of America's Space Shuttle Columbia by NASA artist Chet Jezierski. In this scene, the pressure suits of the fourth Space Shuttle mission are retired along with the press clippings of the first four Space Shuttle orbital flight test missions. The heavy protective garments and helmets that have been the normal attire for Shuttle astronauts at lift-off, re-entry and landing are no longer necessary now that Columbia is operational.

Below are selections from NASA's Space Shuttle art collection to be featured at the National Air and Space Museum Nov. 30 through July 1983. (See article p. 20-22 of this issue.) "Shuttle Launch," pencil drawing by Chet Jezierski (top); "Columbia Launch Fantasy," mixed media by Andreas Nottebahm (bottom).





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Shuttle Flight Five—Pre-Launch Statistics

Crew	Vance D. Brand, commander Robert Overmeyer, pilot William B. Lenoir, mission specialist Joseph Allen, mission specialist
Orbiter	Columbia (OV-102)
Launch site	Pad 39A, Kennedy Space Center, Fla.
Launch date/time	Nov. 11, 1982; 7:19 a.m. EST
Launch window	39 minutes; 7:19—7:58 a.m. EST
Orbit	185-statute-mile circular
Orbital inclination	28.5 degrees
Mission duration	5 days, 2 hrs., 7 minutes or 122 hrs., 7 minutes
Principal cargo	Two communications satellites: Satellite Business Systems (SBS)-C Telesat Canada ANIK-C
Other experiments	Getaway Special Monodisperse Latex Reactor 3 Shuttle Student Involvement Project experiments: Porifera Growth in Zero-G Crystal Formation in Zero-G Convection in Zero-G Orbiter Experiments Package: Aerodynamic Coefficient Identification Package Catalytic Surface Effects Tile Gap Heating Effects Dynamic, Acoustic, and Thermal Environment Infrared Imagery of Shuttle
Principal mission activity	Deployment of SBS-C (flight day one) and ANIK-C (flight day two) EVA (extravehicular activity) (flight day 4) Orbiter Thermal Tests: Side/Sun .... 47 hours Nose/Sun .... 19 hours Passive Thermal..... 10 hours
Preferred landing site	Runway 17, Edwards Air Force Base, Calif.
Weather alternate landing site	Space Harbor (White Sands Missile Range, Northrup Strip), N. Mex.
Contingency landing sites	Dakar, Senegal Space Harbor (White Sands Missile Range, Northrup Strip), N. Mex. Rota Naval Station, Spain Hickam Air Force Base, Hawaii Kadena Air Base, Okinawa
Abort landing sites	Return-to-Launch-Site: Kennedy Space Center, Fla. Abort-Once-Around: Space Harbor, (White Sands), N. Mex. Transatlantic Abort: Dakar, Senegal
Landing date/time	Nov. 16, 1982; 6:26 a.m. PST 9:26 a.m. EST

Shuttle Flight Five—A Mission of Firsts

The fifth flight of the Space Shuttle marks the first operational use of the nation's Space Transportation System. Columbia will transport into orbit two commercial communications satellites, Satellite Business Systems (SBS)-C and Telesat Canada's ANIK-C, as its first task as an operational system. Designated STS-5 (for Space Transportation System), the fifth shuttle mission is scheduled for launch on November 11, 1982 from Launch complex 39, Pad A, at NASA's Kennedy Space Center, Fla. Launch time has been set for 7:19 a.m. EST.

Significant "firsts" for Columbia on this fifth mission will include:

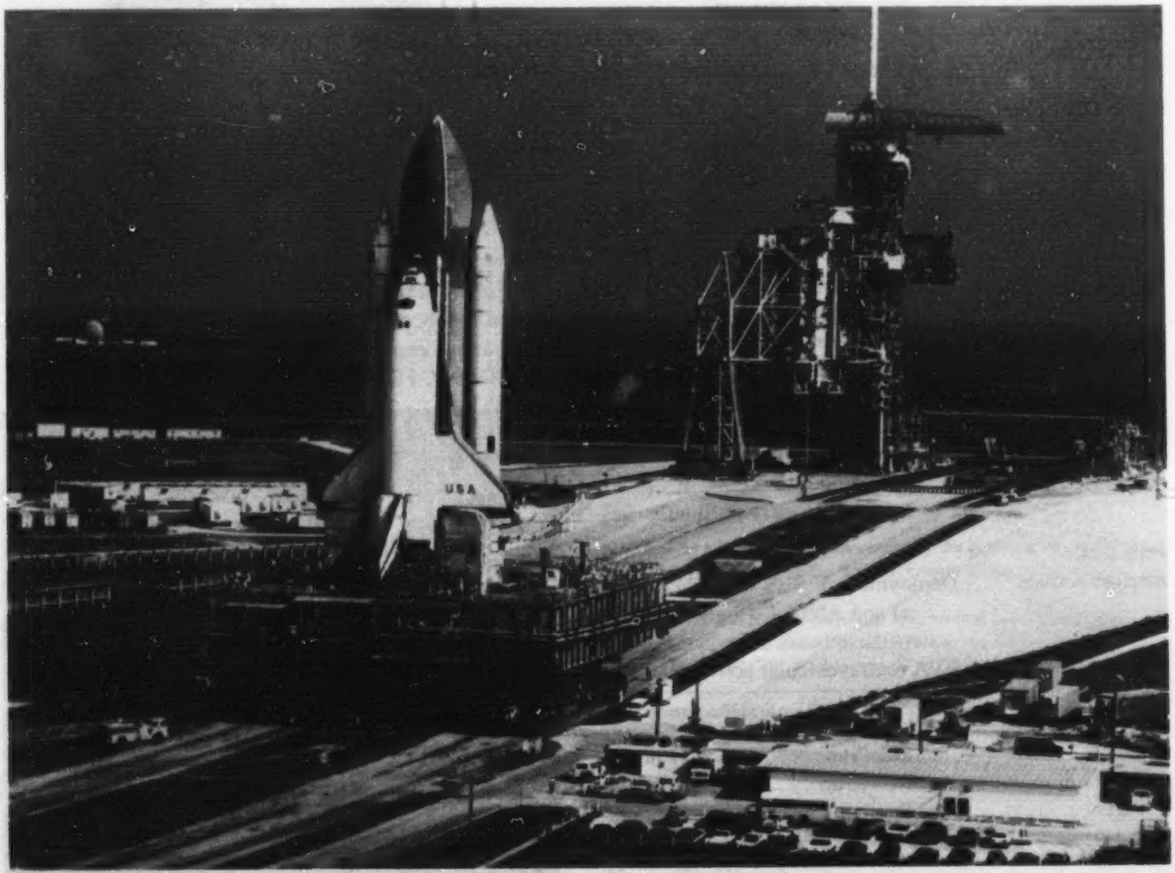
- First Space Shuttle flight to carry and deploy commercial satellites into space.
- First use of the Shuttle payload assist module (PAM)-D and a new ejection system.
- First flight with a crew of four astronauts.
- First flight of mission specialists aboard the Space Shuttle.
- First planned "space walk."
- First demonstration of the Extravehicular Mobility Units in space.

Flight crew for STS-5 is comprised of Commander Vance Brand, 51; Col. Robert Overmyer, 46, pilot; and Dr. William B. Lenoir, 43, and Dr. Joseph Allen, 45, mission specialists. The mission specialists will perform the first extravehicular activity (EVA) ever attempted on a Shuttle flight. Lenoir and Allen will simultaneously go out into Columbia's cargo bay where they will spend approximately three hours testing their space suits' cooling and communications systems, and practicing procedures that might be used for an actual contingency space walk to close balky payload bay doors, repair thermal protection tiles or retrieve a satellite.

Brand was command module pilot of the Apollo Soyuz Test Project (ASTP) flight conducted July 15–24, 1975. He has logged 217 hours and 28 minutes in space. Overmyer was selected as a NASA astronaut when the U.S. Air Force Manned Orbiting Laboratory program was canceled in 1969. He has served on the support crews for Apollo 17 and the ASTP, and was the prime T-38 chase plane pilot for several of the approach and landing tests. Lenoir was selected as a NASA scientist astronaut in 1967. He was backup science pilot for the Skylab 3 and 4 missions and has supported the Space Shuttle program in the areas of payload deployment and retrieval. Allen was selected as a scientist astronaut in 1967. He was a mission scientist while a member of the astronaut support crew for Apollo 15.

Columbia will be launched into a 185-statute-mile circular orbit above the Earth with an inclination to the equator of 28.5 degrees.

Tentatively, the launch window for STS-5 will have a duration of 39 minutes, opening at 7:19 a.m. and closing at 7:58 a.m. EST. The shortness of the window on this flight is due to a daylight landing constraint at Edwards, as well as the other contingency landing sites, and to obtain the proper orbital positioning for deploying the two commercial satellites on the first and second days of the flight.



Rollout 5—Rollout of orbiter Columbia on Sept. 21 for the fifth Space Shuttle launch, now scheduled for 7:19 a.m. EST on Nov. 11.

Columbia will operate in several different attitudes during the 122-hour flight to expand NASA's knowledge of the thermal characteristics of the spaceship. On previous flights, the Columbia has circled the Earth with its nose, tail, bottom and payload bay pointed toward the Sun. On this mission, Columbia will spend 47 hours with its side turned to the Sun, and another 19 hours facing the Sun with its nose propped up about 10 degrees. The remaining time will be spent in a payload bay-to-earth (ZLV) attitude for the deployment of the satellites and the last 10-12 hours before deorbiting.

Scheduled duration for flight five is 5 days, 2 hours, 7 minutes, or 122 hours, 7 minutes. A nominal landing would occur on November 16 at 9:26 a.m. EST, approximately seven minutes after sunrise at Edwards. Columbia again will aim for a lakebed landing on runway 17 at Edwards Air Force Base, Calif. The highest landing priority will be the first completely automated landing of an orbiter from about 20,000 feet to nose wheel touchdown.

Principal cargo to be carried on the fifth Shuttle mission are two commercial communications satellites; Satellite Business Systems (SBS)-C and Telesat Canada's ANIK-C. Other items to be carried in the cargo bay will be a getaway special canister and the development flight instrumentation package. Experiments scheduled to fly in the orbiter's mid-deck include the monodisperse latex reactor and three Shuttle student involvement project experiments. The induced environment contamination monitor and remote manipulator arm have been removed for this flight.

Satellite Business Systems (SBS)-C is the third in a series of business communications satellites, while Telesat Canada's ANIK-C is the first of a trio of satellites that will provide domestic communications services for Canada. Both the SBS-C and ANIK-C spacecraft are built by Hughes Aircraft Co., El Segundo, Calif. The satellites each measure about 2.1 meters (7 feet) in diameter and 6.3 meters (21 feet) tall when deployed in orbit. SBS and Telesat Canada each will pay about $8 million for the launch under a launch services agreement with NASA.

The Shuttle Payload Assist Module (PAM)-D, and a new ejection system will be used for the first time on flight five. A modified version of the PAM has been used as the third stage of NASA's Delta rocket to propel a variety of satellites to geosynchronous altitude.

SBS-C will be the first spacecraft launched out of the cargo bay. It will be deployed about eight hours after liftoff, when the orbiter is over the Atlantic Ocean. The ANIK-C spacecraft will be released on the second day of the mission, on about orbit 22, while Columbia is over the Pacific Ocean near Hawaii.

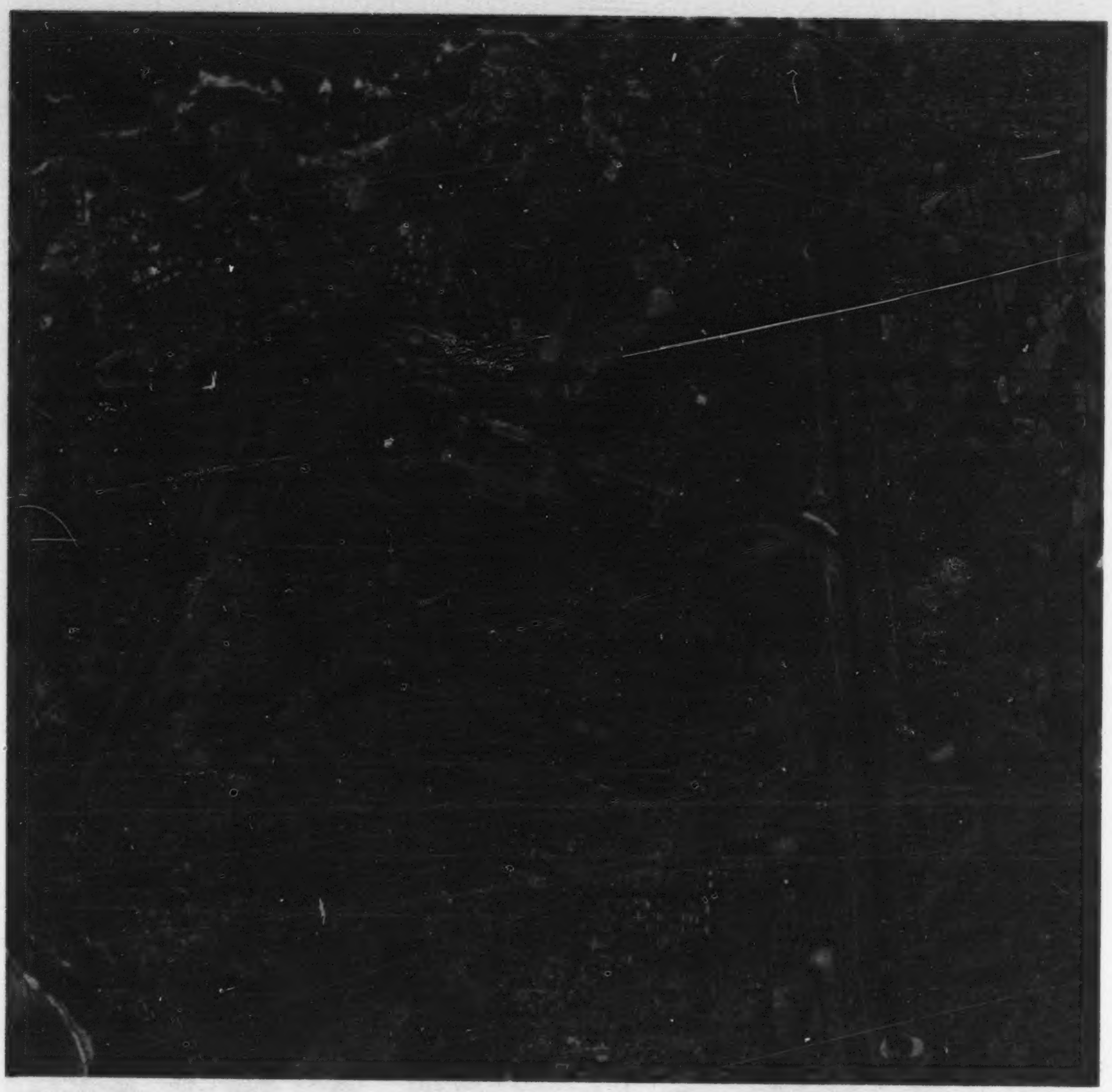
During the final pre-ejection sequence, the orbiter will be maneuvered into a deployment attitude with the open bay facing the direction desired for firing the PAM motor. A clamp is released by explosive bolts and the spinning payload pops out of the bay at a rate of about two and one-half feet-per-second.

At deployment, the PAM is armed to fire automatically in 45 minutes. About 15 minutes after deployment, the orbiter will perform an evasive maneuver to ensure it is at least 8 to 10 miles away from the satellite when the PAM ignites. The PAM motor firing raises the apogee of the spacecraft to about 22,300 miles. On a selected apogee, or high point of the transfer orbit, a solid propellant motor on board each spacecraft is fired to circularize the orbit at the geosynchronous altitude.

After the two satellites have been successfully deployed, the first space walk of the Shuttle program will be conducted. Allen and Lenoir will don pressure suits called extravehicular mobility units (EMU) and backpacks with portable life support systems. They will enter the payload bay through an airlock, hook up safety tethers and traverse down opposite sides of the 60-foot-long enclosure. Holding onto handrails, they will inspect the cargo bay and then move to a stationary tool box and remove a mini work station that will tether them at various worksites. In view of the payload bay cameras, they will test stationary and portable foot restraints, torque and box wrenches, scissors, cutters and ratchet tools to be used on future flights.

The Monodisperse Latex Reactor, one of Columbia's mid-deck experiments, has been carried into orbit on the third and fourth Shuttle flights. Satisfactory results were obtained from the experiment on the third mission. On the fourth flight, some scientific data and experiment objectives were obtained despite an equipment problem. The experiment is used to develop large, identical-sized latex particles. These latex particles may have major medical and industrial research applications.

The Getaway Special scheduled to fly on the fifth Shuttle flight is the first payload of the MAUS project, part of the material science program of the German Ministry of Research and Technology. This experiment will, for the first time, use X-ray recordings to investigate the behavior of metallic dispersions—homogeneous mixtures of two metals. Two metals that are liquid at room temperature, gallium and mercury, will be taken into orbit inside the getaway special canister. A sample will be heated to 220 degrees C (396 degrees F) and kept at that temperature for a



Emergency Landing—Aerial view of Yoff Airfield, Dakar, Senegal, the transatlantic landing site for the fifth Space Shuttle ascent abort. The main runway, running vertically on the right side of the photo measures 3,550 meters (11,647 feet) in length and 45m (148 ft.) in width.

day. The mercury will slowly dissolve into solution with the gallium, much like sugar into a steaming cup of coffee. When the heater is turned off, the sample will cool. On Earth, the mercury would fall out of solution. But in orbit, without gravity, it will not fall to the bottom of the heating chamber and the result will be a mixture of the two metals that is uniformly distributed on a microscopic scale.

Three Shuttle student involvement project experiments will be flown on the fifth Shuttle mission.

In "Growth of porifera in zero-gravity," by Aaron K. Gillette of Winter Haven, Fla., mechanically separated cells of porifera (the common sponge) are to be studied in Columbia's zero gravity to gain better understanding of intercellular communication. For "Formation of crystals in weightless environment," by Michelle Issel, Wallingford, Conn., crystal formation will be observed by heating and then cooling a saturated sodium chloride solution in the weightless environment of the Shuttle. If successful, the process of producing geometrically perfect crystals would be useful to the electronic and other industries. "Convection in zero gravity," by D. Scott Thomas, Johnstown, Pa., will use the weightless environment of the orbiter to study the properties of tension-driven convection in the absence of buoyancy-driven convection. This experiment will be an extension and comparison with similar experiments.

As on previous missions, several orbiter experiments program (OEX) experiments will be flown. These research experiments are designed to record specific data to verify the accuracy of wind tunnel and other ground-based simulations made prior to flight; verify ground-to-flight extrapolation methods; and verify theoretical computational methods. The data will also be useful to further certify the Shuttle and expand its operational envelope. The OEX experiments include:

- Aerodynamic coefficient identification package—to collect aerodynamic data during the launch, entry and landing phases of the Shuttle and establish an aerodynamic data base for verification of and correlation with ground-based data.
- Catalytic surface effects—to verify predictions of the effects of surface catalytic efficiency on convective heating rates.
- Tile gap heating effects experiment—to further investigate the heating phenomena associated with the gaps between tiles to produce a design that will result in heating rates lower than those of the baseline system.
- DATE (Dynamic, Acoustic and Thermal Environment Experiment)—to collect information for use in making credible predictions of cargo bay environments.
- IRIS (Infrared imagery of Shuttle)—will obtain high-resolution infrared imagery of the orbiter during reentry from which surface temperatures and hence aerodynamic heating may be inferred. The imagery will be obtained utilizing a 91.5-cm (36-inch) telescope mounted in the NASA C-141 Gerard P. Kuiper Airborne Observatory positioned appropriately along the entry ground track of the orbiter.

Fifth entry of the Columbia will follow the same course in returning from orbit as did earlier flights: retrofire over the Indian Ocean, atmosphere entry over the western Pacific Ocean, transition to aerodynamic controls in the atmosphere, and a landing as an aircraft. The 3-mile long paved runway at Kennedy Space Center will be the Abort-Once-Around (AOA) and also a contingency landing site.

Columbia's next mission will be STS-9, now planned for launch in September 1983, the first flight of the European-developed Spacelab. Columbia will remain at Kennedy Space Center for major modifications to prepare it for that mission. Orbiter 099, Challenger, is scheduled to make flights 6, 7 and 8 in January, April and July 1983.

Shuttle Mission Five's Getaway Special Payload

Aboard Columbia for the fifth Space Shuttle mission will be a German materials processing experiment. The experiment is the first payload of MAUS (Materialwissenschaftlich Autonome Experimente unter Schwerelosigkeit), part of the material science program of the German Ministry of Research and Technology (Bundesministerium fuer Forschung und Technologie (BMFT)), and the second payload within NASA's Getaway Special program to fly aboard the Space Shuttle.

The experiment, the first of its kind, will use X-ray readings to investigate the behavior of metallic dispersion. An additional objective of the MAUS project is verification of the standard service system, a German-designed payload support structure consisting of a mounting structure, power supply, experiment control, data acquisition, and housekeeping sensors.

X-rays will radiate through two metallic samples, gallium and mercury, which exhibit a miscibility gap in their liquid state. The X-ray process will record periodically their appearance in the liquid state on photographic film during microgravity processing. Elevated temperature treatments will be used to bring these metals into solution; the time needed for this diffusion until complete mixing is achieved will be recorded.

Understanding the physical processes which occur in liquid metals shortly before or during solidification has been hampered by the lack of direct optical observation. Metallic samples which were processed and solidified in earlier space missions had to be analyzed after their return to Earth on polished cross sections. The MAUS Getaway Special utilizing X-ray technology should revolutionize this data collection process.

The next five MAUS payloads are scheduled to fly on the seventh flight of the Shuttle in April 1983, integrated into SPAS 01 (Shuttle Pallet Satellite, a German industrial project), and OSTA 2 (a cooperative NASA-BMFT project). BMFT paid NASA $10,000 to fly the 200-pound MAUS getaway special canister aboard the fifth Shuttle flight.

Technicians examine the first in a series of West German materials processing experiments to be flown aboard the Space Shuttle. This experiment, the second Getaway Special to be sent into space, will take X-ray photographs of gallium and mercury samples as they are heated to the melting point and then allowed to cool at a set rate.

ERNO, the main contractor for the standard service system, has fabricated ten flight units which will be flown on several future Shuttle missions. The MAUS project is managed by the German aerospace research company DFVLR (Deutsche Forshungsund Versuchsanstalt fuer Luft and Raumfart); principal investigator is Dr. Guenther Otto, DFVLR, Institute for Space Simulation.

Shuttle Flight Five Student Experiments

Three experiments, part of the Shuttle Student Involvement Project, cosponsored by NASA and the National Science Teachers Association, are scheduled to be flown aboard the fifth Shuttle flight: **Growth of Porifera in Zero-Gravity,** Aaron K. Gillette, Winter Haven, Fla.; **Convection in Zero-Gravity,** Scott Thomas, Johnstown, Pa.; and **Formation of Crystals in a Weightless Environment,** Michelle A. Issel, Wallingford, Conn. These experiments were chosen from among 1,500 proposals suggested by high school students from across the nation.

Gillette, a junior at Winter Haven Senior High School when he proposed his experiment, is now a freshman at Western Carolina University, Cullowhee, N.C. He will examine the effects of near weightlessness on the formation of sponges. Gillette hypothesizes that cells which form sponges will have difficulty doing so if gravity is not present to enable them to join properly together.

The experiment is composed of 18 bags, each with a solution of separated sponge cells and a packet of special ions, which when released, will enable the cells to begin regrouping. On Earth, once the cells are separated and these ions released, the cells regroup or "reaggregate" to form new sponges. This experiment will determine whether the same process occurs in a weightless environment. Gillette's corporate sponsor is Martin Marietta Aerospace, Orlando Div., where a similar experiment will be performed to provide ground control data.

Thomas, now a freshman at Utah State University, was a junior at Richland Senior High School when he proposed his experiment to study liquid surface tension convection in micro-gravity. Surface tension is the "skin" on a liquid surface, a process that allows a spider to "skate" on water, for example. Surface tension induces flow patterns (convection) in liquids that are heated. Because gravity affects convection on Earth, it is better to study surface tension induced convection in orbit where gravitational effects can be minimized.

For this experiment, up to 15 experimental runs will be conducted in the hour of astronaut time provided. Eight aluminum pans of approximately ¾, 3 and 4 inches in diameter with embedded heaters will hold from 1 to 10 millimeter depths of Krytox oil. The astronaut will inject the oil into the pans with syringes. Video tape, temperature and time readings will be taken of the liquid in which aluminum powder is suspended for visualization.

Data obtained from the experiment will be compared to theoretical predictions and hopefully will lead to a better understanding of surface tension flows in near zero-gravity. Possible applications include a better understanding of certain areas of material processing in space. Thomas' corporate sponsor is Thiokol Corp., Wasatch (Utah) Division.

Issel is a freshman at American University. As a junior at Mark T. Sheehan High School, Issel proposed an experiment to study crystal growth in space, attempting to grow a geometrically perfect crystal in micro-gravity, a feat made difficult if not impossible by Earth's gravity. The experiment involves cooling a triglycine sulfate seed while heating the solution of triglycine and distilled water in which it is saturated. In space, the seed will remain suspended in the solution and grow freely, whereas on Earth the seed's growth is affected by gravity. Issel predicts that in space surface growth of the seed should be uniform and a geometrically perfect crystal should form. If successful, the results will prove beneficial to the electronics and computer industries. Issel's corporate sponsor is Hamilton Standard, Windsor Locks, Conn.

The Shuttle Student Involvement Project is designed to stimulate the study of science and technology in secondary schools. The first such experiment flew aboard Columbia during the third Shuttle flight in March.

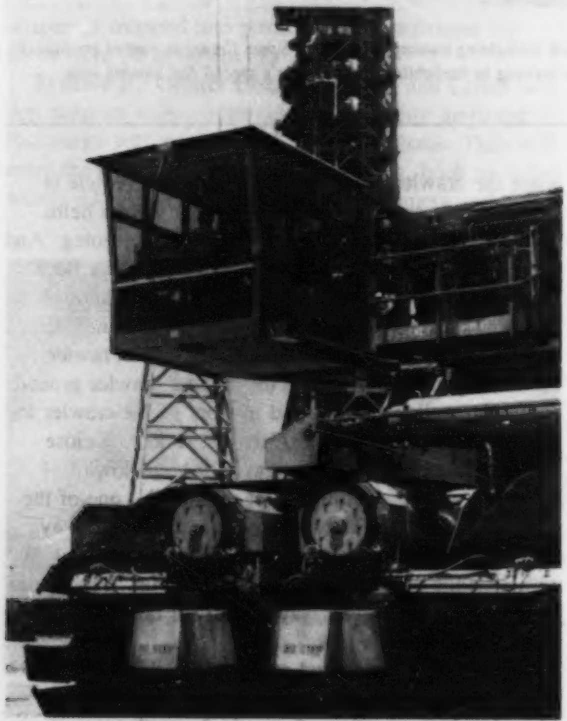
The third project competition is now underway. Requests for entry materials should be sent to: National Science Teachers Association, 1742 Connecticut Ave. NW, Washington, D.C. 20009. Entries are judged at regional and national levels with experiments chosen for Shuttle flight selected from the national finalists.

Behind the Wheel of a 6.3-Million-Pound "Tortoise"

Dick Beck is one of the world's most unusual chauffeurs—not because of who he drives around but because of what. The Boeing Services International engineer is among a select handful of men entrusted to drive the Space Shuttle on its 3½-mile journey from Kennedy Space Center's massive Vehicle Assembly Building to launch pad 39A.

Perched atop a mobile launcher platform, the assembled Space Shuttle is transported to the pad on one of the two giant tracked vehicles nicknamed the mighty tortoise. Formally known as crawler transporters, the 6.3-million-pound vehicles are operated and maintained by Boeing Services International crews who have the responsibility of delivering the Space Shuttle to its launch pad safely and on time.

Beck was at the steering wheel during the most critical phases of Space Shuttle Columbia's rollout to the pad for its first three flights. It may not seem like far to go, but time "crawls" when the Space Shuttle is making its trip to the pad—speed limit for the crawler transporter is one mile per hour. "You don't think one mile an hour is fast until you're rumbling along with 11 million pounds and realize that if you take your mind off what you're doing, you'll be heading for the river instead of the pad," says Beck. His first trip down the



Back view of one of two crawler transporters (left) which carry the Space Shuttle from Kennedy Space Center's Vehicle Assembly Building to launch pad 39A. The one-mile-per-hour vehicles are operated and maintained by Boeing Services International crews at Kennedy. Looming in the background is the top portion of an Apollo launcher. Standing at the wheel in the crawler transporter cab (right), Boeing Services engineer Dick Beck monitors the movement of the transporter. Like at the helm of a ship, Beck gets a better view of the crawlerway if he stands on the job.

Fire Training—Mission specialist Bill Lenoir (second from left) in pre-launch firefighting training at Kennedy Space Center as part of pre-launch preparation. All Space Shuttle crew members and support personnel undergo training in firefighting at the Center's special fire training area.

space center's rock-paved crawlerway was when the last of the Saturn V rockets were transported to the pad for the Apollo-Soyuz mission in 1975. Beck is now lead driver of those qualified to maneuver the giant transporters.

"The first time I drove the transporter, I couldn't get it out of the parking lot," says Beck. Not everybody with a driver's license can hop into the cab of a crawler transporter and go rolling away. The vehicle may have a steering wheel, disc brakes and a windshield, but that's where its similarity to an automobile ends. Eight engineers have been certified to drive the squat vehicles, which resemble flattened tanks and handle like a ship. Each had to pass written exams to qualify, but received their vehicle training on the job.

They take turns relieving one another during the 5½-hour trip to the launch pad. While the crawler transporter can "cruise along" at one mile per hour on the crawlerway, the vehicle must be *inched* slowly out of Kennedy's Vehicle Assembly Building and up the pad ramp. During these critical phases, drivers must keep the crawlers speed to *1/10 of a mile an hour or less.*

Beck and the other drivers only sit in the drivers seat when the crawlers are at a stop. When the vehicle is moving, they stand at the wheel as if it were a helm. "It's the only way you can see where you're going. And even then, the windshield isn't much use," says Beck. He uses a couple of hydraulic hoses near the base of the crawler as a reference point which he keeps lined up with the grassy medium of the crawlerway. Crawler drivers depend heavily upon the Boeing crawler ground crew who walk alongside and in front of the crawler to provide vital guidance to drivers and to keep a close watch on the track for any signs of a breakdown.

"When we were rolling out the Saturn V, one of the pins holding the tracks together came about half way out. One of the guys on the ground knocked it back in with a sledge hammer and we continued on. Driving is just one part of the job," says Beck. "It takes everybody pitching in to do the task."

In the assembly bay and at the top of the pad where movement must be accurate to within a few inches it takes the close attention of everybody on the team to ensure precision. It takes about a dozen engineers, technicians, and mechanics to man the crawler transporter.

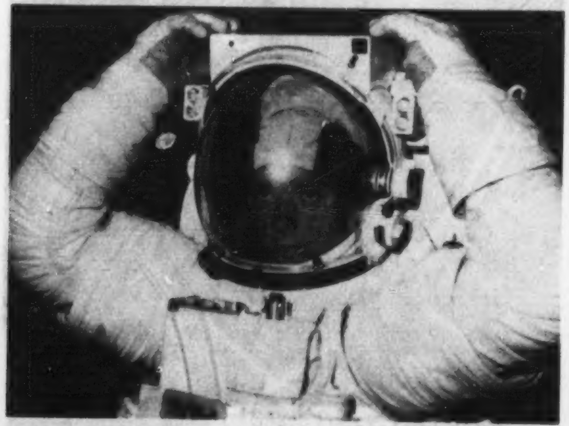
Miniature TV Camera to be Used on Fifth Shuttle Mission

A miniature television camera, its postage-stamp-size lens peeking over Astronaut Joseph Allen's helmet, will give viewers on Earth a first-hand look at what astronauts see during a space walk on the next Space Shuttle flight in November.

The hand-size, 1.1 kilogram (2½-pound) camera will be used during a 3½-hour extravehicular activity on a five-day flight of Columbia after two communications satellites have been deployed. During the space walk, mission specialists Joseph Allen and William B. Lenoir will test onboard tools in the orbiter's payload bay while the camera relays the action to Earth or into Columbia's cabin.

The mini-camera uses a solid state image sensor instead of a vacuum tube and is housed above the helmet's extravehicular visor assembly. Solid state is less complex, and lighter, requiring less power. The camera weighs half that of a similar vidicon tube unit, and transmits live, black and white television scenes. The lens has a 19.7 mm focal length with a 32-degree horizontal field-of-view and normal depth of field from 80 centimeters (32 inches) to infinity. A close-up lens adapter is snapped into position by the astronaut for focus from 30 to 80 cm (12 to 32 in).

To leave the Orbiter Columbia, Allen and Lenoir will don pressure suits—extravehicular mobility units and backpacks with portable life support systems. They will enter the payload bay through an airlock, hook up safety tethers and Allen will turn on the TV camera and lights also mounted in his helmet. Clinging to handrails, Allen and Lenoir will inspect the payload bay, move to a stationary tool box and remove a mini-work station which will tether them at various worksites.



Mission specialist Joe Allen dons a special space suit helmet that houses a miniature solid-state television camera. The postage-stamp size lens is at upper right of the helmet. Allen will use this camera during the mission specialist's "spacewalk" scheduled for flight day four of the fifth Space Shuttle mission.

In view of the helmet and payload bay cameras, they will test stationary and portable foot restraints, torque and box wrenches, scissors, cutter and ratchet tools to be used on future flights. They will also test two winches mounted on the forward and aft bulkheads. The winches manually close the payload bay doors in the event of a door-drive failure.

The helmet camera allows crewmen inside the spacecraft to view the hardware being inspected and permits Commander Vance D. Brand and Pilot Robert F. Overmyer to evaluate the activity.

The miniature TV cameras were developed for the Air Force and produced by Fairchild Weston Systems, Inc., Syosset, N.Y. and are modified for Space Shuttle flight.

Pre-Launch Protection of the Space Shuttle

Each time the Space Shuttle has lifted from the launch pad, it has been protected by a flying "Spectre." Rather than stemming from supernatural powers however, the airborne protection comes from the U.S. Air Force Reserve.

"Spectre" is the name of some sophisticated AC-130A gunships which perform aerial surveillance of the launch area. Flown by citizen-soldiers of the 919th Special Operations Group from an Eglin Air Force Base auxiliary field, the aircraft use a variety of sensitive detectors to make sure no unauthorized persons, vehicles or vessels pose a safety hazard to the launch.

"It's invaluable to us to have the 919th available for Space Shuttle launches," said Capt. Dave Colchin, the Air Force Surveillance Control Officer for Space Shuttle missions. "The infrared scanners and low light level television are especially useful in clearing both land and sea areas." Colchin said that the Spectre aircraft work for Air Force range safety during Space Shuttle and expendable rocket launches, but also are responsible to NASA and the Coast Guard for launch surveillance functions.

"This is a good example of the tremendous support that the Department of Defense provides to NASA," said Ken Lopez, Kennedy Space Center's Chief of Fire and Security. "It's a very necessary service that we'd have great difficulty in providing for ourselves."

All Space Shuttle launches to date have made use of the 919th's Spectre gunships to patrol the immediate

U.S. Air Force AC-130A gunship, part of the 919th Special Operations Group (Air Force Reserve) from Eglin Air Force Base, Fla., used for range safety and launch surveillance functions before a Space Shuttle launch.

launch area as well as to assist the Coast Guard in clearing the flight corridor that extends to the solid rocket booster splashdown area about 160 miles downrange. Two aircraft are normally airborne during a launch, with a third serving as a ground spare.

The aircraft can also serve as search and rescue scanners if the Space Shuttle should be forced to ditch or crash off the coast and a search had to be mounted.

The electronic, radar, infrared and optical surveillance abilities of the aircraft, developed to locate enemy forces and vehicles at night and through dense vegetation during the Vietnam war, are highly adaptable to provide many kinds of aerial observation and search and rescue services.

In the past few years, the 919th has used its special capabilities to provide aerial assistance in widely disparate circumstances. One example occurred early in the unit's transition to the AC-130 in 1975. During an otherwise routine training flight over the Eglin military reservation, a sprawling complex that includes most of the Florida panhandle, one of the unit's aircraft detected an unauthorized vehicle operating far below.

By radio, the aircraft crew alerted and then directed wildlife agents directly to the suspect car for a literal "red-handed" arrest as illegal poachers were dressing a deer carcass.

On another occasion, also over the Eglin area, a crew of 919th Reservists was diverted from a training flight to assist at a train wreck.

Several cars of a train had derailed in the night, and chemical fumes and toxic fumes drifted invisibly through the blackness, endangering citizens, firefighters and rescue personnel alike. The AC-130 made an infrared survey of the wreck site to locate fires and dangerously hot tank cars, and also used low-light-level television to track the movement of the toxic clouds.

In addition, the plane's 2,000 watt searchlight provided aerial illumination for firefighters at the scene. Working through the night, other of the units aircraft provided continuous coverage by flying in relays until the danger had passed.

Most of the time, however, the unit's training flights are used to build skills in the art of close air support. In wartime, the unit's aircraft could be used to help protect and defend friendly troops in close contact with the enemy, or for the destruction of vehicles and supply sites.

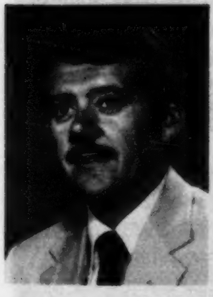
New NASA Personnel and Appointments

NASA has selected a new Chief Scientist, Headquarters, Washington, D.C.; a new Deputy Director of the Goddard Space Flight Center, Greenbelt, Md.; and announced two key appointments in the Office of Space Flight. Dr. **Frank B. McDonald** has been named **Chief Scientist; John J. Quann** has filled the

Work in Zero-G—Scuba divers assist mission specialist Bill Lenoir during an exercise in Johnson Space Center's Weightless Environment Training Facility. Lenoir is fully suited and tethered, practicing chores for his extravehicular activity scheduled for flight day four on the fifth Space Shuttle mission.

position of **Goddard's Deputy Director** and in the **Office of Space Flight, Isaac T. Gillam IV** has been appointed **Assistant Associate Administrator for Policy** and **Richard Wisniewski** as **Assistant Associate Administrator for Institutions.**

McDonald had formerly served as Chief of Goddard's Laboratory for High Energy Astrophysics since 1970. In that role he was project scientist on nine NASA satellite programs including Explorers 12 and 14; IMP (Interplanetary Monitoring Platform) 1-6; and HEAO-1; and principal investigator for many space experiments such as cosmic ray and energetic particles flown on Pioneers 10 and 11, Helios and Voyager spacecraft. During the past year McDonald has been detailed to the White House Office of Science and Technology Policy as a senior policy analyst. As Chief Scientist he will serve as the principal advisor to the Administrator and other senior officials on scientific aspects of NASA programs.



Prior to his new appointment as Center Deputy Director, Quann had been Director of Goddard's Mission and Data Operations Directorate since Oct. 1980. In 1974 he was selected to create and head the Information Division of Goddard's newly formed Executive Office. This Division developed a domestic/decision information display system which facilitated statistical analysis.

Gillam, since last October, has served as Special Assistant to the Administrator for Space Transportation Systems with a special assignment to the White House Office of Science and Technology to assist in the formulation of the National Space Policy. Prior to his assignment at Headquarters, Gillam was Director of NASA's Dryden Flight Research Facility, Edwards, Calif., from June 1978 to October 1981.

Wisniewski had been Acting Director, Institutions and Administration Division in the Office of Space Flight since February 1981. He has held several key assignments at Headquarters including Assistant Associate Administrator for Management and a member of the Headquarters management team which initiated the manned space flight program. Wisniewski began his NASA career as an aeronautical engineer at Lewis Research Center, Cleveland, in 1955.

Inspector General Activities

The following reports are of completed recent investigations by NASA's Office of the Inspector General.

Defective Pricing

As part of an earlier audit conducted by the Defense Contract Audit Agency for NASA, a credit of $13,000 was issued to NASA by a major contractor because of defective pricing. A recent review of the same contract by Defense Contract Audit Agency found further defective pricing in indirect costs. As a result of these findings, the contractor has provided NASA with an additional check for $70,452.

Theft of Government Property

Following receipt of a tip from a local police department, NASA's Office of the Inspector General opened an investigation which resulted in a three-year prison sentence for a former NASA contractor employee.

The employee, involved with the repair of computer terminals, devised a creative scheme for obtaining one illegally. Investigation by the Office of the Inspector General revealed that the employee removed a NASA computer terminal for repair and shortly thereafter reported the terminal stolen to appropriate officials. The employee later legitimately picked up a second terminal for repair, substituted the stolen terminal when the "repair" was completed, and converted the second terminal for personal use. As a result of the investigation, the accused pleaded guilty to possession of stolen NASA property and was sentenced to three years in state prison.

Remarks by Judge William P. Clark National Security Advisor

Symposium on the 15th Anniversary of the Outer Space Treaty

National Academy of Sciences September 15, 1982

The Outer Space Treaty is at least as relevant today as it was when it entered into force in 1967. Its drafters were inspired by the romance and great promise of man's entry into space. They were keenly aware of all mankind's interest in the progress of exploration and use of outer space. They were convinced that activities in outer space should be carried on for the benefit of all people. They were confident that broad international cooperation in space would develop mutual understandings and strengthen relations between states.

These concepts are still viable today. And in fact, the President's new space policy announced on the Fourth of July finds many of its roots in the Outer Space Treaty. Our new policy provides a framework for a vigorous and farsighted space program. Our goals for space are ambitious, but achievable. The great French scientist, Louis Pasteur, once said, "Chance favors only those minds which are prepared."

History has taught us that soothing nostrums, and instant and easy solutions, rarely work. Rather, we must combine our practical experiences with intellectual vision to devise thoughtful and constructive policies that lay foundations for future decisions. The President's space policy effectively lays the foundation that will guide our efforts in space in the years to come.

I'd like to expand on some of the principles underlying the conduct of the U.S. space program. The President has enunciated *a national commitment to the exploration of space in support of our national well being*. In short, the United States is committed to maintaining international leadership in space and to capitalizing on its tremendous potential. We are becoming increasingly dependent on space systems to provide vital services and perform essential missions in both the civil and national security areas. Our programs in space yield the benefits of scientific knowledge and understanding of the Earth, the solar system, and the cosmos.

Historically, international participation in United States space exploration programs has been extremely significant. We will continue to promote, in the national interest, international cooperation in our space program. Cooperation has permitted us to reduce mission costs and to gain access to valuable foreign scientific and technological expertise. International space collaboration also serves broad national foreign policy goals of retaining and strengthening positive, productive relationships with the many countries, both developed and developing, which are benefiting from U.S. space programs. Moreover, widespread international participation in U.S. civil space activities underscores the essential openness of our program. This contrasts sharply with the limited nature of the Soviet program.

At the same time our national program is developing, a highly competitive environment is evolving in the private sector. Space is becoming a workplace laboratory with real economic benefits, and we are encouraging private sector investment and involvement in space activities. Competitive modern communications systems are absolutely dependent on private sector satellites. The desirability of commercializing remote sensing is being assessed. The space launch business, which depends heavily on hardware and services from many U.S. industrial firms, has great potential.

On the last point, let me emphasize that the U.S. is fully committed to maintaining world leadership in space transportation. In his Independence Day address, President Reagan stated that the "United States must look aggressively to the future by demonstrating the potential of the Shuttle and establishing a more permanent presence in space." The Shuttle is a vital element of the U.S. space program, one which is being afforded the attention and concern appropriate to a critical space resource. Because the Shuttle is a national resource, the Shuttle program requires—and is receiving the support of the public and many government departments and agencies.

Our space policy acknowledges the importance of space activities in pursuit of our national security goals. National security space programs shall support such essential functions as command and control, communications, navigation, environmental monitoring, warning, and surveillance. The President has also declared that "The U.S. will continue to study space arms control options. The United States will consider verifiable and equitable arms control measures that would ban or otherwise limit testing and deployment of specific weapons systems, should those measures be compatible with United States national security."

The United States civil space program is second to none and we intend to maintain it that way. We will expand our knowledge of the Earth, its environment, the solar system and the universe. At the same time, we will develop and promote selected civil applications of space technology. Progress in these areas will require substantial efforts by both government and the private sector. Only by working in harmony can we jointly sustain American leadership.

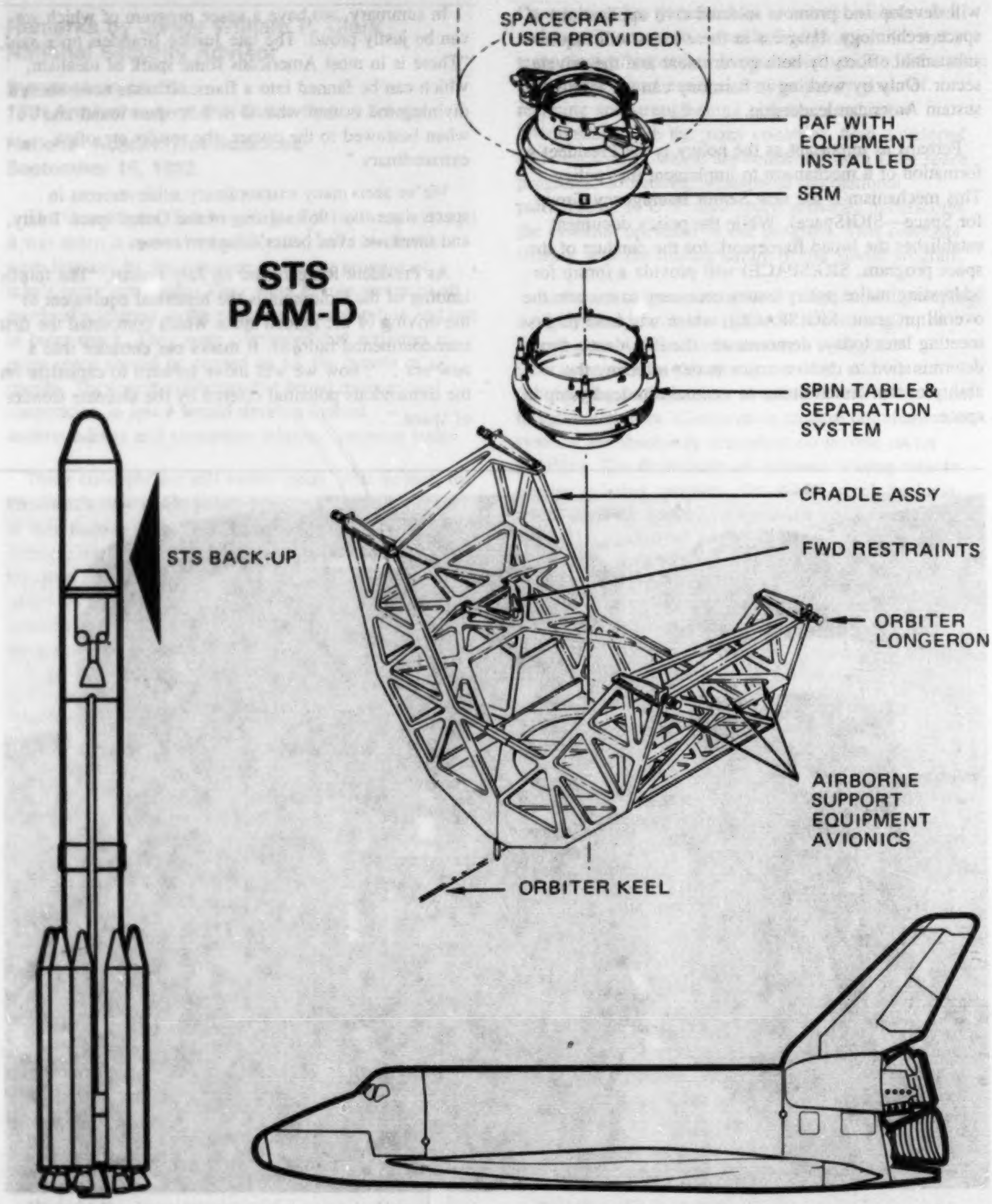
Perhaps as important as the policy is the President's formation of a mechanism to implement that policy. This mechanism is the new Senior Interagency Group for Space—SIG(Space). While the policy document establishes the broad framework for the conduct of the space program, SIG(SPACE) will provide a forum for addressing major policy issues necessary to execute the overall program. SIG(SPACE), which will hold its first meeting later today, demonstrates the President's firm determination to resolve major issues affecting the ability of the United States to maintain its leadership in space.

In summary, we have a space program of which we can be justly proud. The late Justice Brandeis once said, "There is in most Americans some spark of idealism, which can be fanned into a flame. It takes sometimes a divining rod to find what it is, but when found and . . . when bestowed to the owner, the results are often extraordinary."

We've seen many extraordinary achievements in space since the 1967 signing of the Outer Space Treaty, and there are even better things to come.

As President Reagan said on July Fourth, "The fourth landing of the Columbia is the historical equivalent to the driving of the golden spike which completed the first transcontinental railroad. It marks our entrance into a new era . . . now we will move forward to capitalize on the tremendous potential offered by the ultimate frontier of space."

Shuttle 5's Prime Payloads—Technicians work on solar panel mechanisms on two satellites that will be carried into low Earth orbit on the first operational mission of the Space Shuttle: Telesat-E, called ANIK-C in orbit (back left), and Satellite Business Systems-C (front). Each satellite will be deployed from the orbiter's payload bay by a new spinning ejection system; each will later reach geosynchronous orbit using a Payload Assist Module (spinning solid upper stage).


SPACECRAFT (USER PROVIDED)
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SRM
STS PAM-D
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FWD RESTRAINTS
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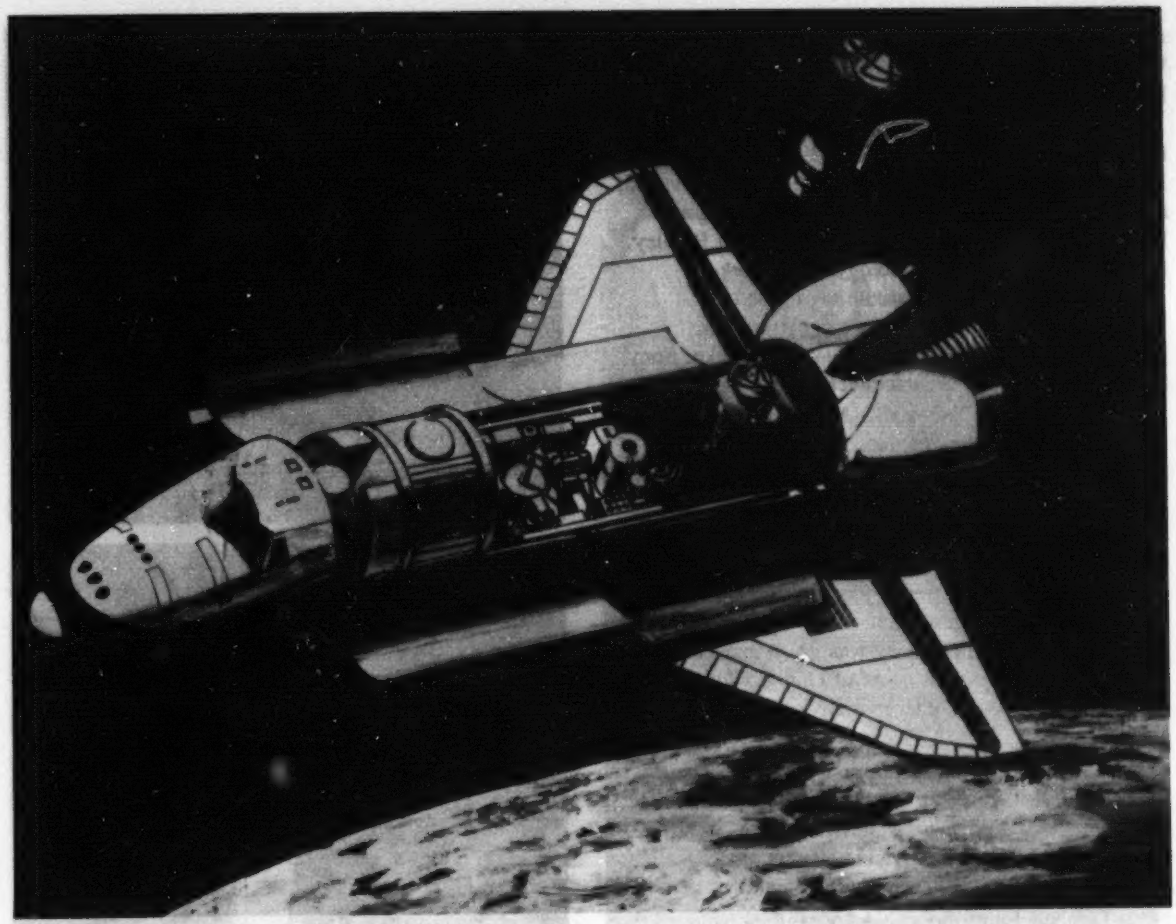
ORBITER LONGERON
AIRBORNE SUPPORT EQUIPMENT AVIONICS
ORBITER KEEL

DELTA 3910/PAM

NASA Verification, Installation & Operations (MDAC Support)



New Satellite Launcher—Under agreement with NASA, McDonnell Douglas has developed two configurations (diagram at left) of a spinning solid upper stage called the Payload Assist Module (PAM). PAM-D (Delta class) and PAM-A (Atlas Centaur class) will provide perigee orbital injection when satellites are launched from the Space Shuttle. PAM-D is designed to be compatible with both the Shuttle and the Delta expendable launch vehicle in order to provide a backup capability for early Shuttle missions. Photo at top shows artist's concept of satellite deployment using the Payload Assist Module.

NASA Participates in Gimbels' "Touch Tomorrow Today"

In an agency first, NASA participated in a major "storewide" futuristic exposition called "Touch Tomorrow Today" sponsored by Gimbels department store of New York. The agency's collection of displays and models was the largest NASA exhibition ever to appear in New York. Gimbel's total exposition, from Sept. 19 through Oct. 8, featured over 40 exhibitors, covered 25,000 square feet of space on nine floors and drew approximately one million spectators.

The three-week event was hailed by Gimbels as a "forum for American industry, government and arts"—an opportunity for the American public to find answers to questions about what the future holds in the areas of communication, science, space, recreation, the arts, working and living in space, clothing, money, and education.

The focus for "Touch Tomorrow Today" was on participation and public information—not commercialization. Gimbels assured NASA that at no time would agency exhibits be used as an endorsement or promotion of sales either in the store or in media advertisement of the exposition.

The Gimbels exposition featured exhibits on aerodynamics, space technology, computers, arts, energy, environment, recreation and fashion were gathered from major U.S. manufacturers, government, universities and scientists to provide the public with a preview of life in the eighties and beyond.

Participants included: NASA, Alabama Space and Rocket Center, Alfred University, Black & Decker, Bulova, Clarkson College of Technology, Compuvision, Ford, FTC Services, Man-Made Fiber Association, Massachusetts Institute of Technology, Milton Bradley, New York Institute of Technology, New York Telephone, International Institute of Applied Technology, Philadelphia College of Art, Omni, Polaroid, Rensselaer Polytechnic Institute, Seiko, Sony, Syracuse University, Techniclothes, and Vectrex.

NASA astronauts Thomas K. Mattingly and Henry W. Hartsfield, the crew of the fourth Space Shuttle mission, officially opened the exposition on Sept. 19 with a ribbon-cutting ceremony. They later narrated a film report on their flight, the final mission in the Space Shuttle orbital test flight series, in Gimbels sixth floor auditorium.

NASA was the largest participant in "Touch Tomorrow Today": the agency was given exclusive use of the fourth and seventh floors of Gimbels for exhibits and shared space with other participants on the first and sixth floors.

NASA's experimental wind tunnel model of the supersonic cruise research aircraft was featured on the first floor. Also on display were two murals: an artist's rendering of the Shuttle servicing a future space station and a photomural of a Space Shuttle launch.

On Gimbels fourth floor, NASA exhibits included the Lunar Rock, one of only two touchable moon rocks on exhibit in the world; and beam builder, spacelab, and space suit displays. Panels showed future space station concepts: space platform, a design study conducted at NASA's Marshall Space Flight Center, Huntsville, Ala., and a space operations center, developed at NASA's Johnson Space Center, Houston. Video presentations included "Jupiter, the Giant" and "Fun in Space."

On the sixth floor, NASA presented five lectures a day on aeronautical and space sciences. The half-hour lectures and demonstrations were given by space technology experts from NASA and covered subjects such as rocketry—up to and including the Space Shuttle; space science information on the moon and the planets of the solar system; and the latest innovations in aeronautics and spinoff technologies. In addition, reproductions of paintings from NASA's art program were on display which featured twelve works by America's leading artists.

Finally on Gimbels seventh floor, NASA's exhibits focused on the applications of space technology with

Touch a piece of the
MOON

Scenes from NASA's exhibition at "Touch Tomorrow Today" a futuristic exposition sponsored by Gimbels department store of New York from Sept. 19 through Oct. 8. NASA's collection of displays and models was the largest agency exhibition ever to appear in New York. NASA astronauts, T. K. Mattingly and Henry Hartsfield, crew of the fourth Space Shuttle mission, officially opened the exposition on Sept. 19 with a ribbon-cutting ceremony.

such displays as: a scale model of the Space Shuttle highlighted by panel displays explaining the role of the Shuttle in the future—its use as a "space truck" for earth-orbiting laboratories, solar power satellites, space stations and interplanetary mission launch platforms. Other panel displays discussed the personal, home, medical and health benefits derived from space technology, including the development of fire-resistant materials.

Curators for Gimbels "Touch Tomorrow Today" exposition were Robert P. Gersin Associates, designers for exhibitors at three World's Fairs including Expo '82 in Knoxville and the U.S. Pavilion at the 1975 World's Fair in Japan.

NASA Shuttle Art to be Featured at National Air and Space Museum

NASA's Space Shuttle program has been captured in a unique type of archival history: art. This ever expanding collection of over 200 works of art tells the Shuttle story in widely varying concepts—from abstract fantasy to photographic realism—and in artistic mediums that range from pencil sketches to oil paintings.

From Nov. 30 through July 1983, a special collection of NASA's Space Shuttle art will be featured at the National Air and Space Museum, Washington, D.C. Following this eight-month showing, the collection will be sent to major cities across the nation on a 1-2 year traveling art tour, sponsored by the Smithsonian Institution Traveling Exhibit Service (SITES).

The NASA art program began in 1962 at the recommendation of Administrator James Webb who saw the need to use interpretive artwork as a means of documenting the "spirit as well as the sights of the space age."

The first group of artists was dispatched to cover Gordon Cooper's final Mercury flight in May 1963. Documenting the next ten years of spaceflight through the Gemini and Apollo program were such famous artists as Norman Rockwell, Jamie Wyeth and Robert Rauschenberg.

In 1976, NASA's graphics coordinator, Robert Schulman, was asked to revive the agency's art program for the new age of the Space Shuttle; it had become dormant after the agency's space race for the moon during the decade of the seventies.

Artists who agree to participate in the agency's art program donate their time and talent in return for an honorarium to cover expenses; their finished works of art become the property of NASA. And they have captured on canvas the Shuttle's story as it has evolved: spacecraft rollout from the Rockwell assembly plant in California; simulation and hardware tests at NASA's Marshall Space Flight Center, Huntsville, Ala.; orbiter processing work in the Orbiter Processing Facility and Vehicle Assembly Building at NASA's Kennedy Space Center, Fla.; the historic moment of the first launch pad rollout; and finally the unique aerospace vehicle's launch and landing.

Artists participating in the Shuttle art program bring to the assignment a wide range of talent and artistic approaches to the subject matter and include such modernists as Lamar Dodd and Robert Rauschenberg; traditional illustrator Arthur Shilstone; Bob McCall, participating member since the inception of the agency art program in the sixties, who designed the advertising art for the film 2001: A Space Odyssey; Wilson Hurley, noted for his Western landscapes; Bill Robles, courtroom illustrator for the Charles Manson trial in the late 1960's; and Henry Casselli, first official Marine combat artist in Viet Nam.

NASA's Shuttle artists are free to interpret the subject matter of their choice—no one within the agency dictates how they should work or what is expected of their final product.

As Bob Schulman, NASA art program coordinator explains: "Although the artwork produced for the Space Shuttle collection presents a wide range of techniques and styles from the very realistic approach to abstract images and impressions, the "harmony" is obvious to those who have the privilege of viewing this fine work. Each painting depicts an intimate human record for future generations to view some very exciting moments of the Space Shuttle story as seen through the eyes of the artist. Along with documenting the space effort in every way possible, these paintings stand on their own as works of art."

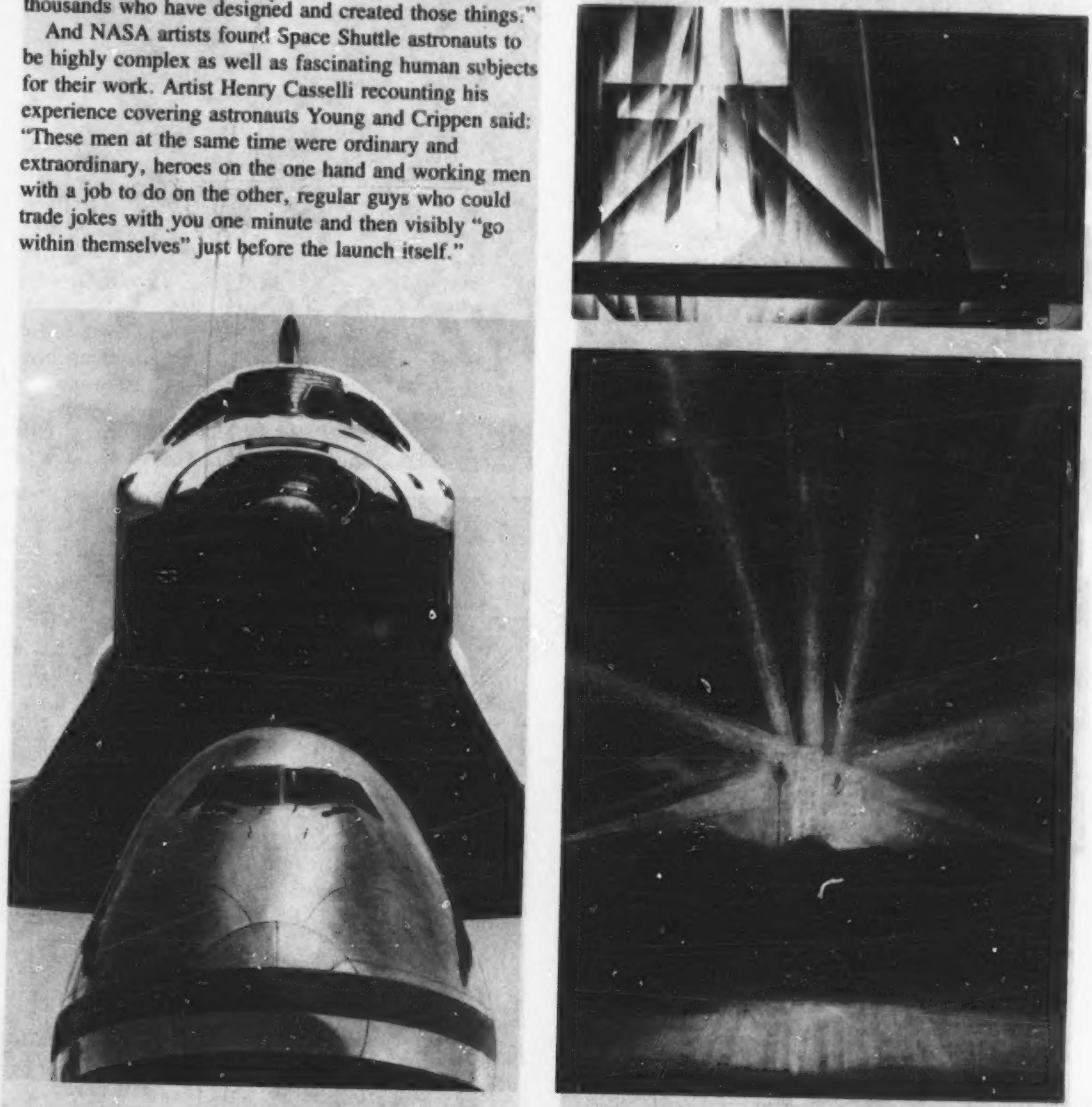
The artists participating in the NASA art program join an established heritage of recording historic events through art—including the settlement of the West, the Civil War and World Wars I and II.

For many of the artists, a great challenge lies in covering the excitement of a Shuttle liftoff on canvas. After the first Space Shuttle launch, artist Wilson Hurley commented: "The launch is the most exciting event I have witnessed in my life, and it will probably take me years to assimilate my feelings to where I can produce paintings that come close to the thrill it gave me."

The technology of the Space Shuttle program also captured artistic imaginations. "My first thought," said illustrator Paul Salmon, "was to not get involved in drawing technical equipment and machinery because I do people subjects. But once you get out there (Kennedy Space Center) you realize there is so much humanity—even a tossed-aside hunk of metal can look like a well thought out piece of art because the craftsmanship is so superior. The humanity is in the thousands who have designed and created those things."

And NASA artists found Space Shuttle astronauts to be highly complex as well as fascinating human subjects for their work. Artist Henry Casselli recounting his experience covering astronauts Young and Crippen said: "These men at the same time were ordinary and extraordinary, heroes on the one hand and working men with a job to do on the other, regular guys who could trade jokes with you one minute and then visibly "go within themselves" just before the launch itself."

As for how Space Shuttle engineers and scientists regard the contributions made by NASA's art program, illustrator Paul Salmon responds: "I suppose that some of them might laugh at our interpretations of what they do, but the funny thing is that later they'll have the paintings hanging on their wall."



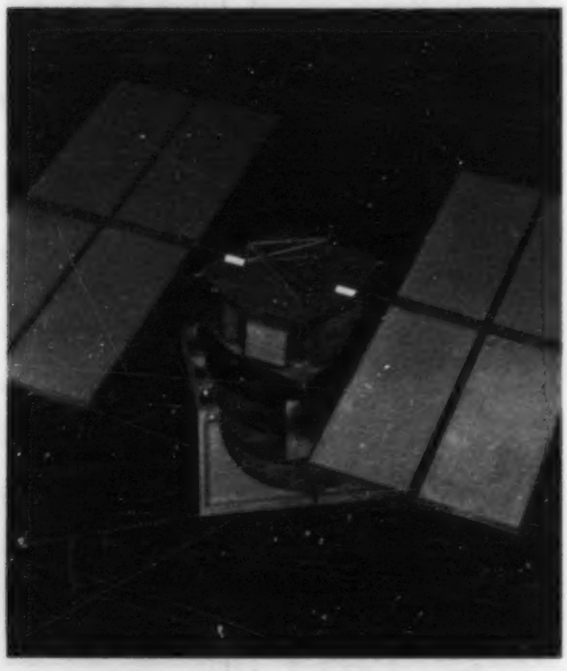
Selections from NASA's collection of Space Shuttle art to be featured at the National Air and Space Museum, Nov. 30 through July 1983. **This page, left column:** "Challenger, Edwards Air Force Base, July 4, 1982," acrylic by Ron Cobb. **Right column, top:** "Florida Coast—Sunset," acrylic by James L. Cunningham; **right column, bottom:** "Night Watch," watercolor by James Dean. **Page 22, top left, clockwise:** "T plus 2:11," acrylic by Linda S. Richards; "The Aftermath," watercolor and gouache by Charles Schmidt; "Columbia at 30 Seconds," oil by Wilson Hurley; and "On the Pad and Launch," acrylic by Paul Salmon.

Potential of Mini Space Platform to be Studied

NASA and Fairchild Space and Electronics Co., Germantown, Md., have signed a Memorandum of Understanding initiating discussions for a new on-orbit mini space platform to be serviced by the Space Shuttle. Under the memorandum, NASA and Fairchild will study the potential for a joint endeavor agreement leading to development of a small space platform to be on orbit and available to commercial customers by 1986. Fairchild would be responsible for leasing room on the platform commercially, as well as for providing technical and administrative support for the venture.

The platform, called Leasecraft, would be orbited by the Shuttle and left in space indefinitely. The Shuttle would then return periodically to install or remove payloads. The platform itself would provide the various payloads with power, stabilization, communications and the ability to change orbit.

The lower cost and the flexibility of Leasecraft versus satellites that incorporate all of the hardware for the services to be provided by the platform, is expected to attract widespread commercial and government interest.



Artist concept of Leasecraft (left), a mini space platform that could be placed on orbit and available to commercial customers by 1986. Leasecraft is a concept currently under study via a joint endeavor agreement between NASA and Fairchild Space and Electronics Co., Germantown, Md.

NASA Names Tenth Shuttle Mission Astronaut Crew

Four of the five crew members who will man the Space Shuttle on its first dedicated Department of Defense mission have been selected: NASA astronauts Thomas K. Mattingly, commander; Loren J. Shriver, pilot; Ellison S. Onizuka and James F. Buchli, mission specialists. The fifth crew member, an Air Force manned spaceflight engineer, will be named at a later date.

The tenth flight of the Space Shuttle is currently scheduled for launch from the Kennedy Space Center in the last quarter of 1983. This flight will be the fourth mission using the Space Shuttle Challenger.

Thomas K. Mattingly

Loren J. Shriver

Ellison S. Onizuka

James F. Buchli

Computer Simulations Speed Up NASA's Aeronautical Research Programs

As the pilot breaks through the bottom layer of clouds in a leaden sky, he can just see the rain-washed decks of the destroyer in the rolling seas about 500 feet below him. He's flying a new type of plane. It's a tactical aircraft called a Harrier, and it has four movable nozzles that allow the thrust of its single jet engine to be directed either aft for conventional flight or downward for vertical takeoff and landing and for hovering.

As the ship rides to the crest of each long swell and then slides into the trough, the landing deck in the stern alternately rises and falls a total distance of some 30 feet. The pilot is holding the plane stationary now, directly above the ship, hovering, waiting for the one right exact moment to ease down and meet the heaving deck. All four nozzles are directed downward, providing lift, but no forward motion. The landing will be tricky at best. The last time, he crashed. But he learned something then, and this time he'll make it.

Actually, *the last time was five minutes ago,* and there were no injuries or damage to the plane or ship because the pilot never moved away from his TV monitor. It's all part of an amazingly realistic on-the-ground training flight that's being computer-simulated, and it's just one example of how scientists at NASA's Lewis Research Center are using computers in aeronautical research.

The program for this simulation, which improves computer execution time ninefold, was written at Lewis. It had to be developed specially because both propulsion and flight control on the Harrier are provided by the plane's jet engine, making for unique handling characteristics.

Lewis is NASA's lead aeropropulsion center, working in concert with other NASA aeronautics research facilities emphasizing airframe technology (Langley Research Center, Hampton, Va.) and flight testing (Ames Research Center, Moffett Field Calif., where the flight simulator is located.)

At Lewis, computers aid aeropropulsion research in a number of related areas: propulsion, propulsion aerodynamics, fluid mechanics, aerothermodynamics and fuels, and structures and mechanical technologies. In each area, computers are being used to:

- *Simulate and predict* what will happen outside in the real world by using mathematical models that stay inside the computer;
- *Gather and integrate* massive amounts of data that the latest technology and monitoring devices can generate in a short time;
- *Analyze and correlate* all of the computations to provide scientists and engineers with the necessary understanding of the aerodynamic, structural and propulsion phenomena that must be coordinated and unified into a just-so-combination to design and build a modern aircraft.

In effect, computers can help design aircraft engines of the future, or improve those operating now, at a fraction of the cost, in time and money, otherwise required, if indeed the engine wanted can be built at all.

Savings are achieved by Lewis researchers primarily in three ways: (1) design and concept testing can be done before any actual hardware need be built, (2) a more advanced design is possible when prototype hardware is constructed, and (3) test time for hardware in wind tunnels and in test aircraft is shortened dramatically, saving, in some instances, years of testing time.

Besides doing them cheaper, computers at Lewis do some tasks now that were impossible before what one NASA scientist has called the "age of computational plenty." Due to sheer size and the number of calculations needed to reach a solution, some problems were, for all intents and purposes, unsolvable in the "slide rule age." In fact, certain computations done easily by today's computers would have taken so long on the computers of yesterday that the time required to solve them would have exceeded the life expectancies of the old machines.

For example, in the design of jet engine inlets and nozzles, engineers no longer have to settle for the simplifying assumptions required for two-dimensional computer analysis. Three-dimensional analysis and the extra computational load it imposes now can be absorbed with the greater capacity of modern computers. New computers also are making possible the great strides achievable in propeller design for high-speed aircraft of an extremely advanced design that has the potential of giving a plane jet-powered performance on one-third less fuel.

Lewis scientists now are finding potential in another area to do things that simply weren't possible in the past. When combined with the nonintrusive measurement capability of a laser beam, for example, computers appear to have the ability to find areas for design improvement that cannot be reached with mechanical probes and from which data could not be gathered because of their physical inaccessibility.

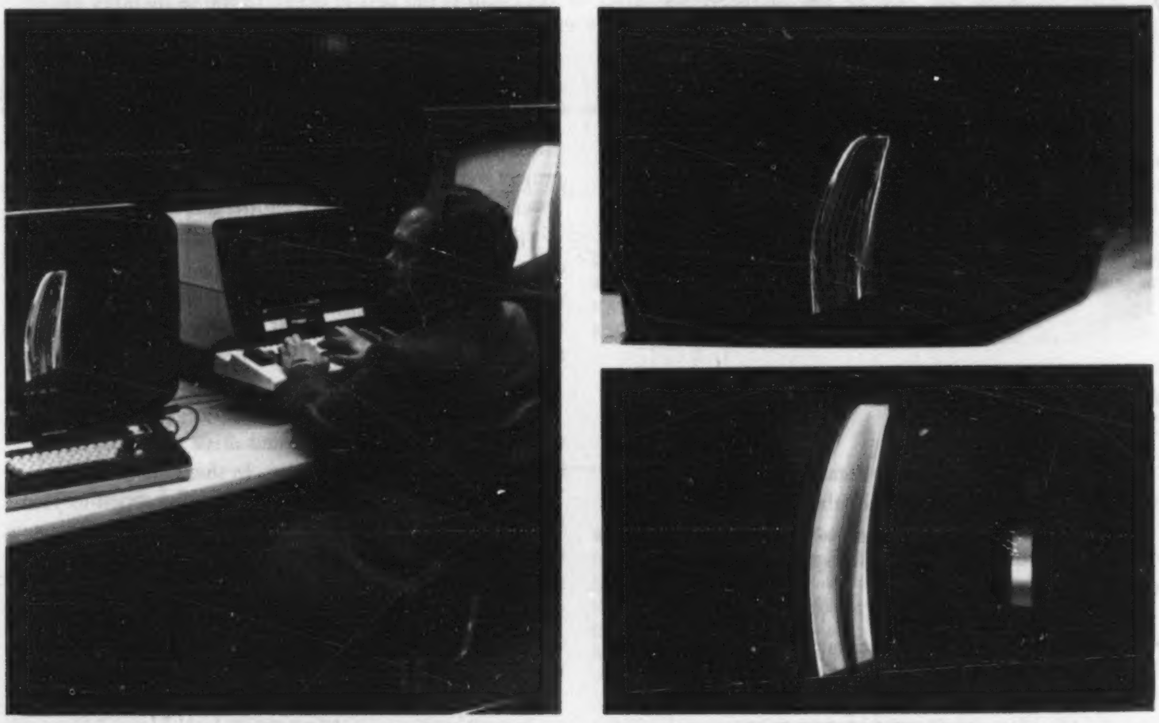
Use of computer graphics (computer-generated images that are shown on a TV-type screen) permeates all Lewis efforts in aeronautical research. One example involves the study of what goes on inside the combustor, the part of a jet engine in which the fuel and air are burned. By factoring into a computer program such variables as the type of fuel, method of injection into the combustor, and the temperature and pressure of the fuel/air mixture, a visual representation of the combustion process can be generated. As each variable is changed by giving the computer new instructions, the effect on the combustion process can be observed. What actually appears on the screen resembles a color time-lapse movie of storm clouds moving across the sky and helps designers gain an understanding of the combustion process that isn't possible from just looking at equations and tables of numbers.

But the study of the principles of operation and the processes inside a modern jet engine presupposes the existence of the engine itself. That, too, must be designed and then built. Hence, the study of structures and mechanical technologies and research in the field of tribology, which deals with lubrication, friction, wear and the general process of what happens when moving parts move togehter.

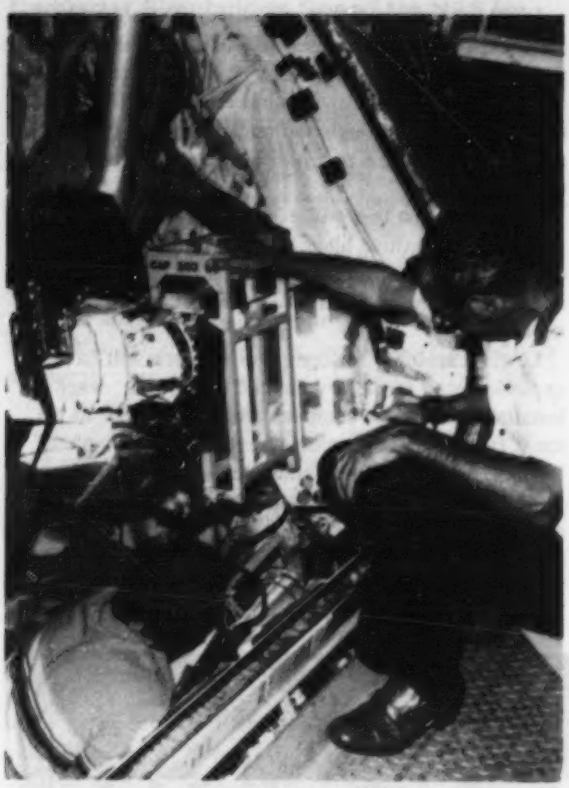
In the area of computational structural mechanics, for instance, computers are used to analyze the effects of temperature and load variations on a component. Here, using the computer, Lewis engineers can perform much more complex, thorough and realistic testing than is possible by putting a part into even the most advanced test equipment.

Programs exist that will evaluate the structural response of a turbine blade to aerodynamic, thermal, centrifugal and impact loadings on a part. Even the impact of a bird on a fan or compressor blade can be simulated.

Lewis' capability for computer research will have expanded even further by the end of the year, when the installation of a new computer that will be four to ten times faster than current equipment will be completed. Because much more trial-and-error work will be done much faster by using mathematical models, experimental facilities such as wind tunnels can be used for fewer and shorter runs, thus not only saving time but conserving energy as well.



Use of the latest in computer technology illustrated in this application of graphic analysis to propeller research. A new analytical tool, the three-dimensional Euler lifting surface propeller computer analysis (photo at left) has been developed to design propellers for high subsonic speed aircraft. The different speeds of the air flowing over particular portions of those advanced propeller blades are predicted by the program and are represented as a line drawing (top right). Color is added (bottom right) to the computer generated image to show the areas of varying air speed. Red is used to indicate the highest air speed (the color assigned to the triangular shape in the line diagram) yellow to indicate the intermediate speeds, and blue, the lowest air speed.



New Communications—Workers install a new Ku band antenna in the payload bay of the orbiter Challenger in Kennedy Space Center's Orbiter Processing Facility. This device will allow the spacecraft to communicate with an advanced Tracking and Data Relay Satellite in a high frequency range much less crowded than the S-band now used. The first flight of Challenger is scheduled for Jan. 1983.

Marshall Concludes First of Two-Part Contract on Robotics

Robots have long been associated with spaceflight and spacecraft in the movies and popular press. But except for robotic devices such as the Space Shuttle's remote manipulator arm, use of robots in space has been limited thus far.

NASA, however, sees potential for real-life cousins of the movie robots. Marshall Space Flight Center in Huntsville, Ala., under funding from NASA's Office of Aeronautics and Space Technology, has been working with the Massachusetts Institute of Technology, Cambridge, on a study to see how they might best be used in space. The study addreses both robotics and an even more exotic, related field called "telepresence."

The first phase of this two-part study was recently concluded, according to the Marshall Center's study manager George Von Tiesenhausen. "The purpose is to make future missions more affordable," said Von Tiesenhausen, "by having humans doing only those tasks they do best. Humans have dexterity and can do delicate work, and they are better prepared to deal with unexpected events and make on-the-spot decisions. And humans can intervene when machines fail. Machines, on the other hand, can take over failure diagnosis and maintenance tasks, and can do 'housekeeping'—for example, keep the on-board systems running."

In the part of the study just completed, MIT examined three areas. "First," said Von Tiesenhausen, "the institute was to investigate what kinds of tasks have been planned in space over the next 15 years or so. Secondly, it was to research the state-of-the-art over the next decade or more. Thirdly, MIT was to match the two—the automation and the tasks—to find for each activity the automation available."

In the study, the institute arrived at some 70 generic activities that cover a broad spectrum of missions. The activities were then arranged into an organized format. "Marshall is the first to organize the technology of automation," said Von Tiesenhausen. "There was no structure within the entire automation community before now.

"And the matching of tasks with automation has a broad-brush effect—we can use these matches when a project manager wants to review what's available for a specific project he's proposing for the future."

The second part of the contract now underway concerns "telepresence," and is a specific application extracted from the first part of the contract. "The idea of telepresence evolved from MIT's Marvin Minsky, and the concept involves a lot of automation," said Von Tiesenhausen. "The example I'm fond of using is 'driving a car by telepresence': you'd get into a remote control device in New York and drive an empty car through traffic in Los Angeles. In the machine in New York, you would have a lot of sensors strapped to your hands and legs, and you would see what the camera saw from the empty automobile in Los Angeles. If you turned your head to the left or right, the camera in the Los Angeles vehicle would do the same. With telepresence, you could do things in space as if you were really there."

The telepresence half of the MIT study contract will run until May 1983. It will concern itself with two questions: Based on present automation technology what technology gaps must be filled in order to build an initial telepresence system and what kind of demonstration program is needed to verify telepresence applicability to space tasks.

"Our present robotic equipment is much too heavy and clumsy for telepresence," said Von Tiesenhausen. "An automated arm, for example, weighs 900 kilograms (20,000 pounds) and requires 10 horsepower to run it. A human arm weighs 4.5 kg (10 lb.) and needs only a few watts. That's one of the differences between human and robotic capabilities.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
James S. Sovey, Ralph Forman, Arthur N. Curren and Edwin G. Wintucky, NASA/LeRC	Ion sputter textured graphite	4,349,424	LeRC
Percy H. Rhodes and Robert S. Snyder, NASA/MSFC	Electrophoresis device	4,349,429	MSFC
Bruce A. Banks, NASA/LeRC	Mechanical bonding of metal	4,349,954	LeRC
Peter O. Minott, NASA/GSFC	Multiprism collimator	4,350,410	GSFC
Glen E. McDonald, NASA/LeRC	Method for depositing an oxide coating	4,350,574	LeRC
Carlisle R. Dolland and Daniel W. Trimble, Airesearch Mfg. Co., Torrance, Calif.	Combinational logic for generating gate drive signals for phase control rectifiers	4,351,022	MSFC
Jan Harper-Tervet, Warren L. Dowler, Shiao-Ping S. Yen and William A. Mueller, Caltech/JPL	Coating for gasifiable carbon-graphite fibers	4,351,878	NRO/JPL

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OV-102)	March 22	KSC	OSS-1
*Columbia (OV-102)	June 27	KSC	DOD 82-1
Columbia (OV-102)	November 11	KSC	SBS-C, ANIK-C

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* Successful launch

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
*Telesat-G (Anik-D1)	August 26	Delta	ESMC	Canada communications. Reimbursable.
*Intelsat V-E	September 23	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*RCA-E	October 27	Delta	ESMC	RCA communications. Reimbursable.

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* Successful launch

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Pocket-Size Electronic Detective

An aerospace spinoff of electronic circuitry has produced the Electronic Nose*, a device which detects flammable liquid "accelerants" in post-fire situations where arson is suspected. Accelerants are combustibles such as gasoline or benzene which are used by arsonists to speed up the spread of fire. Deliberately-set fires kill more than 1,000 people per year across the nation and cause injuries to thousands more, at a cost of about $5 billion annually.

Speedy detection of physical evidence by the "Nose" has helped expedite arson investigations by law enforcement agencies, firefighters and insurance companies.

The small pocket-size device is powered by a rechargeable battery and is so simple to operate that users need no special training. The investigator holds the Electronic Nose about an inch above the suspected material; if an accelerant is present it will trigger the "Nose" to beep and emit a flashing light. The faster the beep, the more volatile the accelerant.

The extremely sensitive device can detect the presence of accelerants several days after a fire and in such minute trace quantities as less than 50 parts per million.

The Electronic Nose is also useful in other applications such as detecting hazardous fumes, locating gas spills that have seeped into sewer systems and detecting gas leaks in refineries and on oil drilling rigs. Manufactured by Grace Industries, Inc., Transfer, Pa., about 1,000 units are produced per year. Electronic Nose is presently used in criminal justice courses taught at the University of Texas, Austin, and in seminars conducted by Dr. Richard W. Henderson (shown in photo) at Francis Marion College, Florence, S. Car.

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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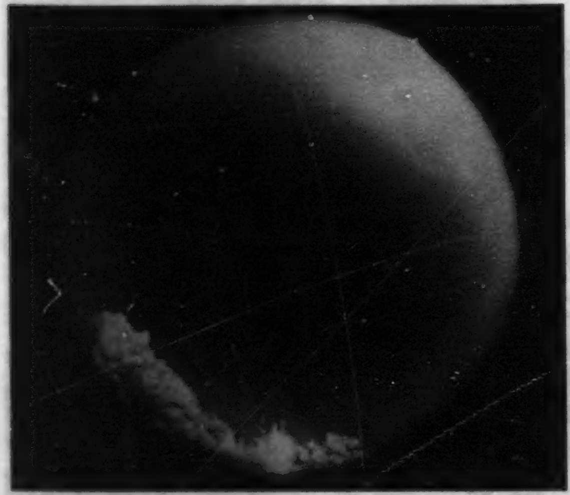
About the Cover

Artist concept of Space Shuttle maneuvering to deorbit burn for reentry to the Earth's atmosphere from low-Earth orbit. *(Photo courtesy of Nikon.)* The fifth launch of Space Shuttle Columbia on Nov. 11 inaugurated the Space Transportation System as "operational": carried aboard Columbia for this flight were two commercial satellites—Satellite Business Systems-C and Telesat Canada's Anik-C, deployed on flight days one and two, respectively. At the completion of this flight on Nov. 16, Columbia had travelled approximately 11 million miles. Below are photos of the launch taken by Mike Lawton for NASA, made using a Canon F-1 body with a 7.5mm fisheye lens set at 1/500th at f-8.5. Top photo is an enlargement of the bottom frame.



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Administrator's Column

(In this column *NASA Activities* features an article by NASA Administrator James M. Beggs. These articles focus on subjects chosen by him that address topics of broad interest to the agency's employees.)

NASA's Space Station Planning Activity

Since my last column on NASA's space station effort (*NASA Activities*, July edition, p. 18-20), we have made significant progress in the agency's space station planning activity. In this column I will update these achievements for you and will outline where NASA will be going with this activity in the months ahead.

NASA does not yet have an approved program for a space station. We are, however, conducting an extensive planning activity. This activity is intended to define the elements of a space station program for the Administration and for Congress, to enable each to make an informed decision as to whether there should be a national commitment to a U.S. space station as NASA's next major space initiative.

I remain firm in my belief that a space station, as a permanent presence in space, should become NASA's next major goal. Such a program follows the logical development of our Space Transportation System, now operational with the successful completion of the fifth Shuttle mission in November. The Space Shuttle program was originally conceived to include a space station, a system in which the orbiter would shuttle payloads to and from a station in low Earth orbit.

From NASA's planning activity coordinated by the Space Station Task Force set up in May, we will know: (1) what missions a space station will support; (2) the architectural and systems requirements needed to support these various scientific, commercial and defense missions; (3) the estimated cost of a space station; (4) the technological risks involved; and (5) the scheduling required to develop, design, construct and place a station in low Earth orbit by the beginning of the next decade.

In August, NASA signed contracts with eight major aerospace firms for space station mission analysis studies. These studies are intended to define with specificity the various scientific, commercial and defense missions that could be conducted and supported by a space station. From these studies architectural options for a space station will be derived and first-order costs will be estimated.

The eight companies selected to perform the eight-month mission analysis requirement studies are: Boeing Aerospace Co., Seattle; General Dynamics Corp., Convair Div., San Diego; Grumman Aerospace Corp., Bethpage, N.Y.; Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.; Martin Marietta Aerospace, Denver Aerospace, Denver; McDonnell Douglas Astronautics Co., Huntington Beach, Calif.; Rockwell International, Space Operations/Integration and Satellite Systems Div., Downey, Calif.; and TRW, Inc., Defense and Space Systems Group, Redondo Beach, Calif.

Parallel with NASA's mission analysis studies are independent studies being conducted by the European Space Agency, Canada, Japan, France, Germany, and Italy. International interest in NASA's space station planning effort is high, derived in part from current cooperative activities between NASA and organizations in these nations that have resulted in contributions to the Space Transportation System program; other past and present cooperative activities with NASA; and recognition by these countries that a U.S. space station could be the next large space initiative.

The European Space Agency, Canada, Japan, Germany and France are conducting their own mission analysis requirement studies in phase with and in complement to NASA's own efforts in this area. Italy has extended its tethered satellite system study to include possible applications of tether concepts to a space station. A summary of the mid-term reports of NASA's mission analysis contractors will be presented to the foreign space agencies and the foreign agencies will report to NASA on the status of their studies in early December; a final summary meeting involving an information exchange between the NASA mission analysis contractors and the foreign space agencies has been scheduled for February. Final written results will be completed by April 1983.

This past September, in complement to NASA's mission analysis studies, four small study contracts were awarded by the Marshall Space Flight Center to define dimensions of space station activity.

The four firms selected for these studies are: Boeing Aerospace Co., Seattle; Martin Marietta Aerospace, Denver; TRW, Inc., Redondo Beach, Calif.; and General Dynamics Corp., San Diego.

Each contractor will address a specific operational area. Boeing will look at the role of a manned space station with regard to building such large structures in orbit as huge communications antennas. Martin Marietta and TRW will examine servicing and maintenance of satellites from a manned facility. General Dynamics will examine the relationships of the space station with an "orbital transfer vehicle"—a vehicle for moving payloads from lower to higher orbits. The transfer vehicle could be kept in space and serviced by a manned facility.

Space station studies also are being sponsored by the Kennedy Space Center, which has awarded two small contracts. The first reviews ground operations needed to support a space station launch, concentrating on pre-launch assembly, checklist and interfaces. The second contract is a one-year analysis of space station operations, using the Center's unmatched experience in ground operations. The focus will be on assembly and activation, daily operations, maintenance, safety and payload operations.

In concert with all these space station studies, NASA has begun to examine space station systems requirements and definition that would support various architectural and future design requirements. Space station systems requirements focus on engineering. They can be defined as those systems needed to build a space station and make it operational.

As an example, we will learn from mission analysis studies that a space station needs to have and supply power at a specific rate level, say 10 kilowatts. Systems definition examines the ways in which this power can be supplied such as fuel cells, batteries or solar power. Involved as a parallel effort are trade-off studies to determine the best way to get the power source needed under such specific operating constraints as budget or the state of specific technology advancement.

In support of the space station systems definition and mission analysis activities is the planning of technology for a space station being conducted by the Space Station Technology Steering Committee. This committee, part of the Office of Aeronautics and Space Technology, is assessing the readiness of various technologies in support of an early space station launch. It is also drafting plans to augment technology research in critical areas, for transfer to the advanced development stage that is directed by the Space Station Task Force. These two activities, technology research and advanced development, are key elements in our overall space station planning.

Another area of consideration in NASA's space station planning activity is industry's involvement in this effort—in particular, their need for a space station and their potential for building a station using non-government industry funding. NASA has signed a Memorandum of Understanding with Space Industries, Inc., Houston, to examine how related commercial ventures may be an important element of NASA's overall space station program and to develop industry's architectural requirements for a station. The space station concept(s) developed by Space Industries, Inc., will effectively support those missions defined by NASA's mission analysis studies. Results of the study by Space Industries, Inc., are to be submitted within two months following the completion of NASA's mission analysis studies (about June 1983).

From this brief recitation of ongoing space station studies, it is apparent that an extensive planning activity is underway. All the NASA centers are involved. All of the Headquarters program offices are participating. It is essential that our space station activity retain this characteristic and be perceived as a total NASA program. The space station is the key to our future. As such it does not belong to any one element of NASA. It belongs to us all.

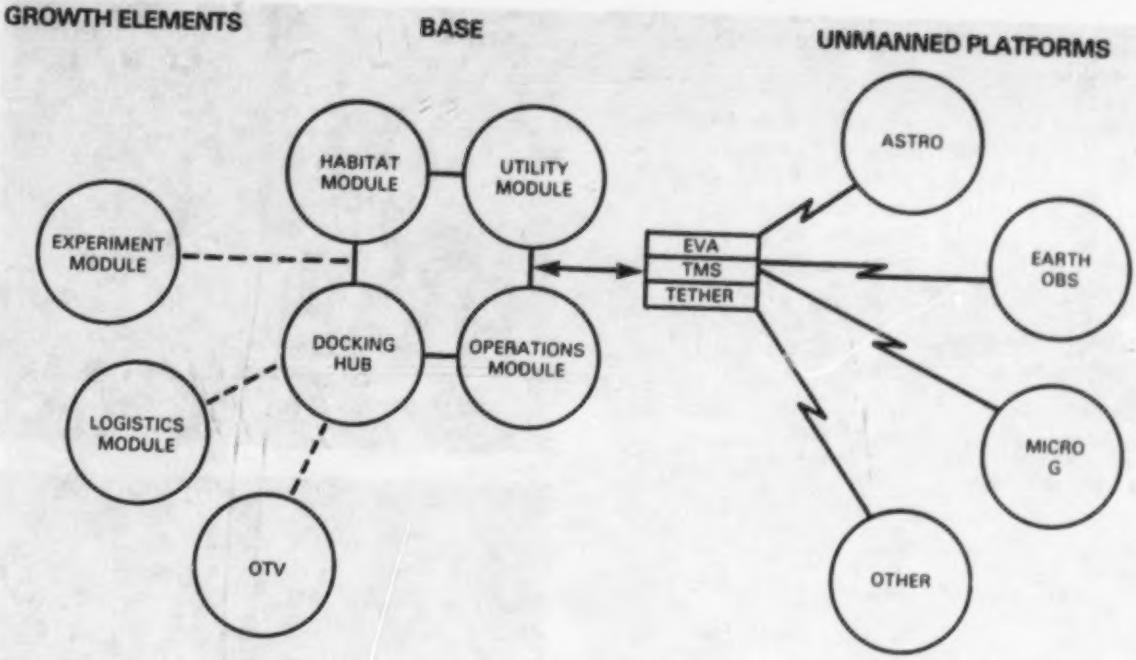
Our space station activity touches upon many current NASA activities. For example, NASA and Fairchild Space and Electronics Co., Germantown, Md., recently signed a Memorandum of Understanding to study the potential of a small space platform to be placed on orbit and available to commercial customers by 1986.

This platform concept, called Leasecraft, follows a concept developed in earlier space station studies performed at Marshall. Leasecraft would consist of a simple platform structure designed to support various instruments or fully automated experiments.

The structure would be placed in low Earth orbit and tended by the Space Shuttle. It would be designed with the capability of providing payloads with power, stabilization, communications and the ability to change orbit. Fairchild would be responsible for the commercial leasing of space on the platform for instrumentation.

Leasecraft's orbiting platform concept can be seen as one element of what NASA envisions as the overall space station concept or architecture. Taken to its full potential, this architecture probably would involve a modular cluster concept with both manned and unmanned elements as shown on page 5. The base units comprising this station would be a habitat module, a power/utility module, a docking hub and an operations module. Linked with this base would be various unmanned platforms bearing instrumentation to support such experiments as astrophysics, earth observation, and zero gravity. Growth elements to be added to the space station as it evolves to a full operational capacity could include an experiment module, a logistics module and an orbital transfer vehicle.

NASA also is beginning to review and debate the subject of how to manage a space station program.



Space station architecture: cluster concept.

Areas that are being examined are: the role of Headquarters, the relationship between Headquarters and field centers, and the relationship between centers.

Consideration also is being given to acquisition strategies. Of prime interest is systems engineering and integration efforts. Should NASA select a prime systems engineering and integration contractor excluded from other major activity or should we have this function performed through a traditional prime contractor? This question and many others deserve careful consideration. I urge all of you to let the Space Station Task Force know of any ideas and suggestions you wish to contribute. They are welcome and solicited.

NASA hopes to receive its first substantial space station planning funding in fiscal year 1984. With proper funding we could assume a launch by 1990 or 1991. Current rough estimates of cost through launch phase is $4-6 billion. This is a relatively modest amount which I believe is defensible in view of the total budget outlook, both for NASA and the government at large. I also believe our thorough planning efforts will result in a "green light" from the Administration and from Congress to pursue a space station as NASA's next major goal—one which will further challenge our technology, hone our skills and ensure our pre-eminence in space during the 1990s.

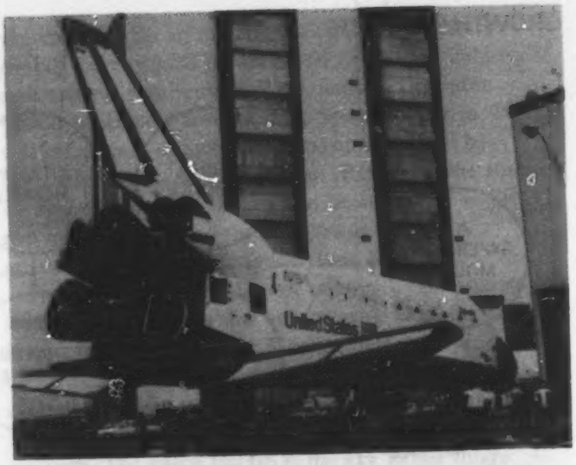
I recently quoted a passage from a 1979 James Michener speech as a good summary of NASA's current challenge and opportunities today. He said:

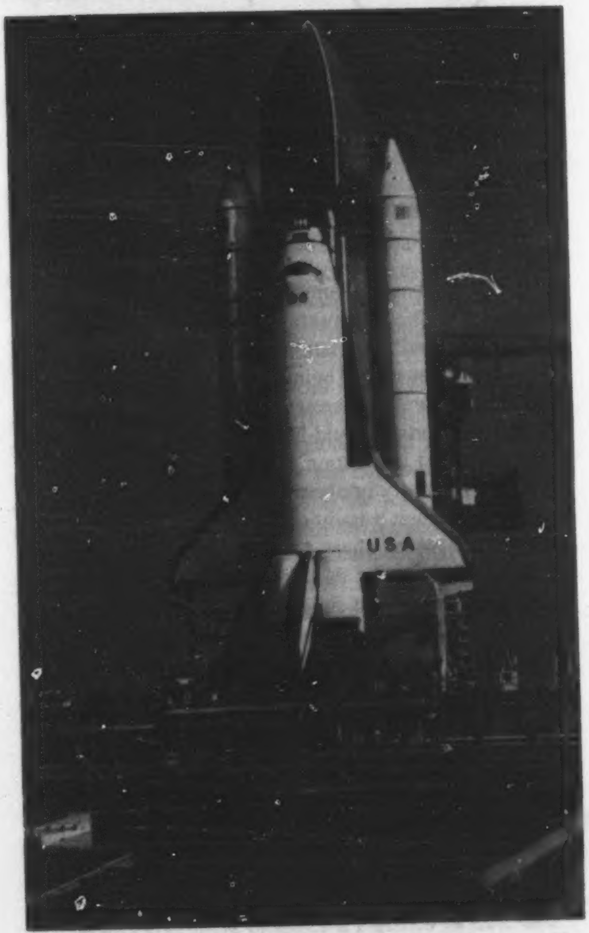
"Each era of history progresses to a point at which it is eligible to wrestle with the great problem of that period. For the ancient Greeks it was the organization of society; for the Romans it was the organization of empire; for the medievalists, the spelling out of their relationship to God; for the men of the fifteenth and sixteenth centuries, the mastery of the oceans; and for us it is the determination of how mankind can live in harmony on this finite globe while establishing relationships to infinite space."

A space station is NASA's next vital link in achieving this last relationship. It is the means by which the United States can fully and routinely utilize space, the last frontier, for the benefit of all the people of our planet. Mr. Michener may have outlined what some would label as a "tall order." It is one, however, that I believe NASA is capable of achieving. An orbiting space station symbolizing our nation's permanent presence in space is the key which will unlock the door to this challenge.

Space Shuttle Mission 5—Pictorial Highlights

Crew:	Vance D. Brand, commander Robert F. Overmyer, pilot William B. Lenoir, mission specialist Joseph P. Allen, mission specialist
Columbia arrival at Kennedy Space Center from Edwards	July 15
Time in Orbiter Processing Facility	July 16-Sept. 9
Rollover to Vehicle Assembly Building	Sept. 9
Rollout	Sept. 21
Launch date and time	Nov. 11; 7:19:00.0678 EST
Launch site	Kennedy Space Center, Fla. Pad 39A
Landing date and time	Nov. 16; 9:33:25 a.m. EST
Mission duration	5 days, 2 hrs., 14 min., 25 sec.
Orbits	80 full orbits Deorbit burn for reentry on 81st orbit
Payload deployments	SBS-C Deployed 11/11/82; 3:17 p.m. EST Anik-C Deployed 11/12; 3:24 p.m. EST

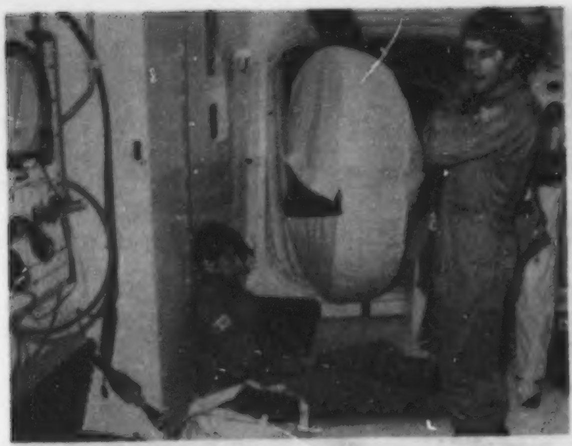


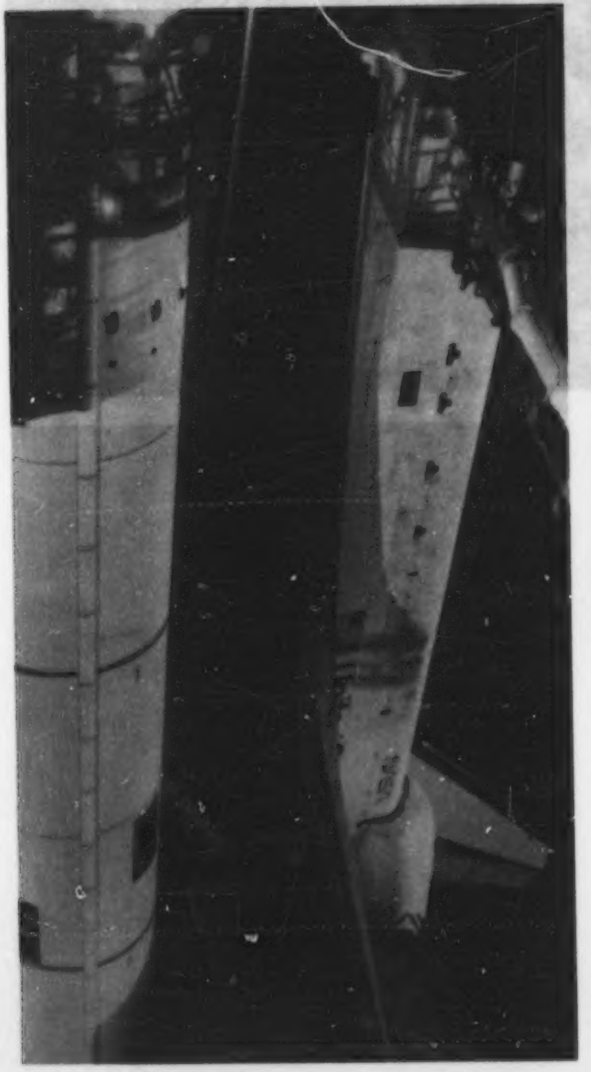


Rollover of Columbia on Sept. 9 (top photo) to the Vehicle Assembly Building, Kennedy Space Center, for mating with the external tank and twin solid rocket boosters. Rollout of Columbia (bottom photo) to launch pad 39A, Kennedy Space Center, Sept. 21.

NASA T-38 chase plane (top photo) carrying Shuttle Mission 5 astronauts Vance D. Brand, commander, and Robert F. Overmyer, pilot, bound for Kennedy Space Center on Nov. 9. This photo was taken from another T-38, one which carried mission five's other crew members, mission specialists Bill Lenoir and Joe Allen.

Shuttle 5 crew members at their pre-launch breakfast (bottom left); the crew decided to forego the traditional steak and eggs breakfast, opting instead for a light meal of cereal and juice. At right, the crew depart Kennedy's Operations and Checkout Building for the launch pad, dressed for Columbia's first operational flight in lightweight coveralls.

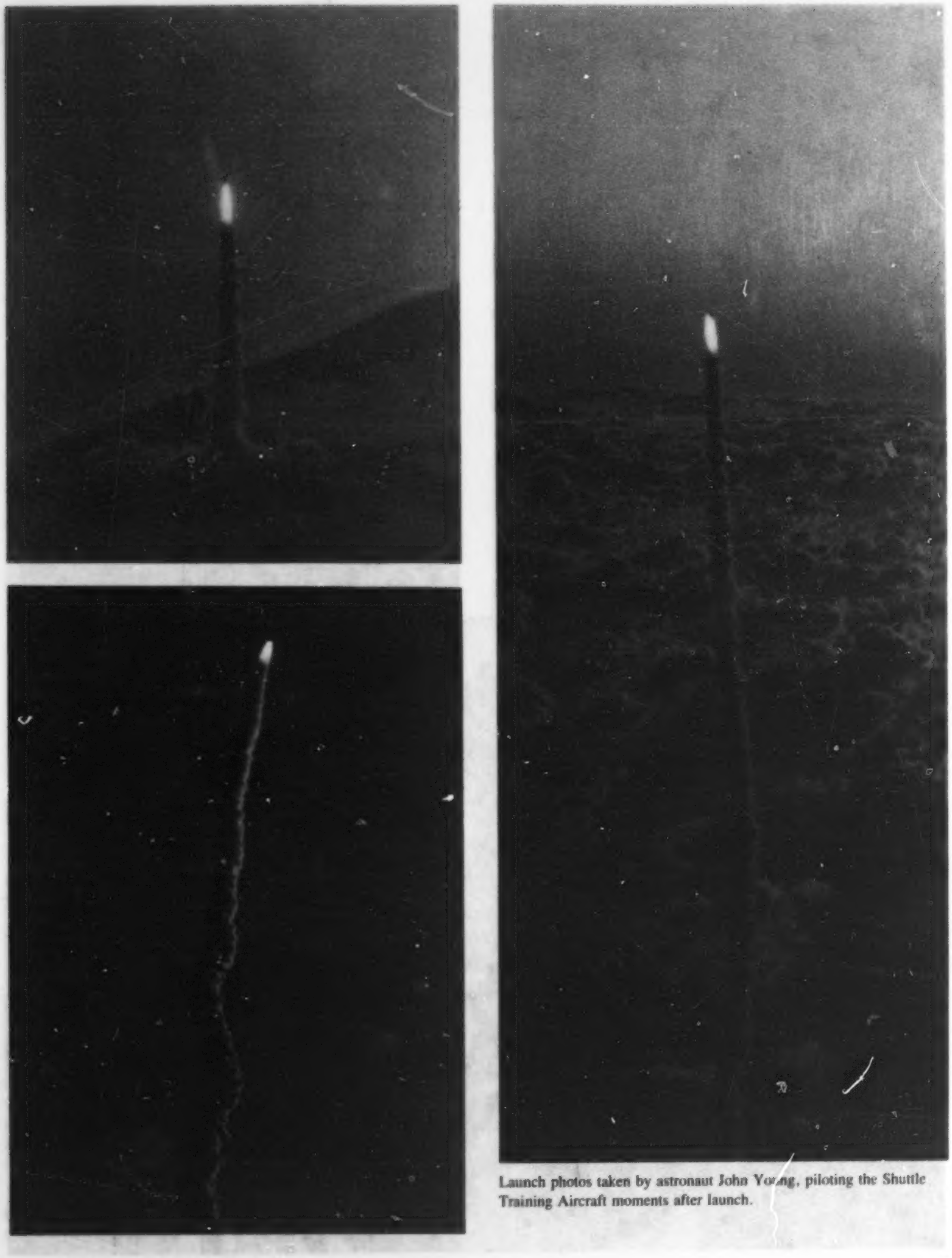




Mission specialist Joe Allen (right) prepares to ingress Columbia launch morning, Nov. 11 (photo top left). On his face and head are electrode monitors to record his reflexes during the launch. Mission specialist Bill Lenoir (lower left) waits for the moment to enter Columbia's open hatch at center.

Rare pre-dawn view of Columbia (photo bottom left), one of its two solid rocket boosters and huge external fuel tank. This photo was taken by Joe Allen from the service structure connecting passageway to the White Room.

Fifth launch of Space Shuttle Columbia Nov. 11, 7:19 a.m. EST (top). This has been hailed as a mission of firsts: the first U.S. space mission to carry a crew of four; the first flight of NASA mission specialists; the first operational flight of the Space Transportation System in which two commercial communications satellites were deployed into space.



Launch photos taken by astronaut John Young, piloting the Shuttle Training Aircraft moments after launch.

Astronaut Bill Lenoir trims pilot Bob Overmyer's sideburns (photo top left).

Joe Allen, on the orbiter flight deck, lets a spot meter float free for a moment during a session of out-the-window photography of Earth from the orbiting Columbia (top right).

"We Deliver Gang"; fifth Space Shuttle crew members display a sign referring to their successful deployment of two commercial communications satellites.

SATELLITE DEPLOYMENT BY
Ace Moving Co.
WE DELIVER

Mission specialist Joe Allen and Bill Lenoir participating in biomedical tests in the mid-deck area of Columbia (top photos). Electrodes have been connected to their faces for monitoring responses in zero gravity.

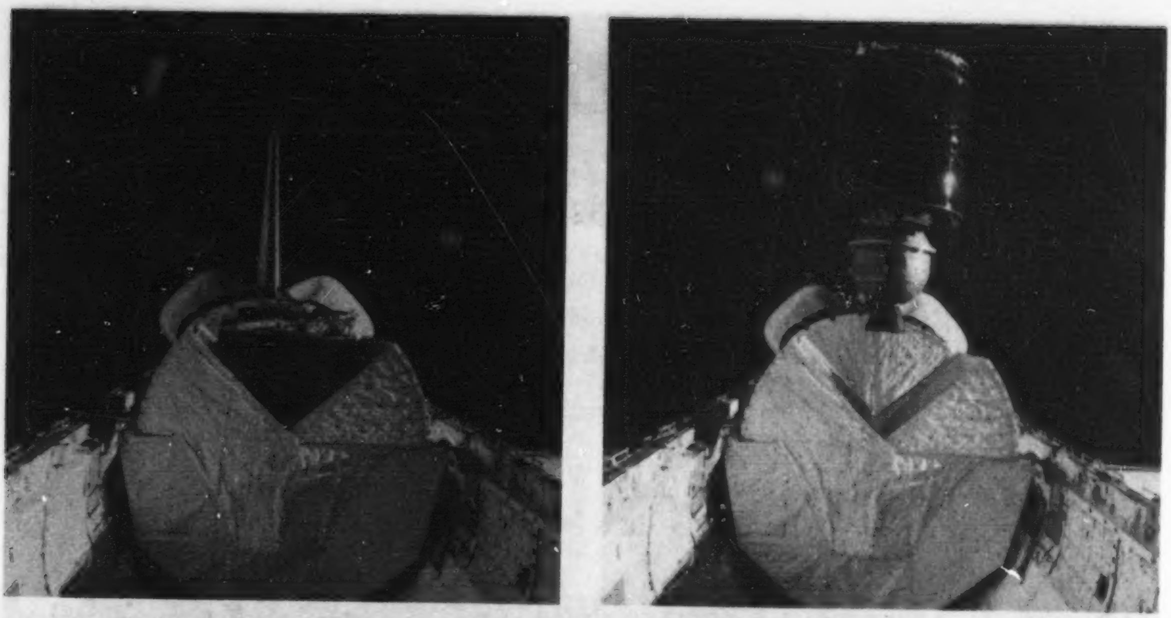
Bill Lenoir uses a cartoon (bottom left) to greet ground controllers at Mission Control during flight day four.

Scott Thomas, a Shuttle Student Involvement Project winner, sits at the payload console in the Mission Control Center (center photo) watching astronaut Joe Allen conduct his experiment in convection in zero gravity. At right, the kangaroo mascot (chosen for its carrying capability) for the payload team gives Scott a stare.

Mealtime aboard Columbia (bottom right photo). Mission specialists Allen (top center) and Lenoir in floating positions; astronauts Brand (far right) and Overmyer in more conventional sitting positions.

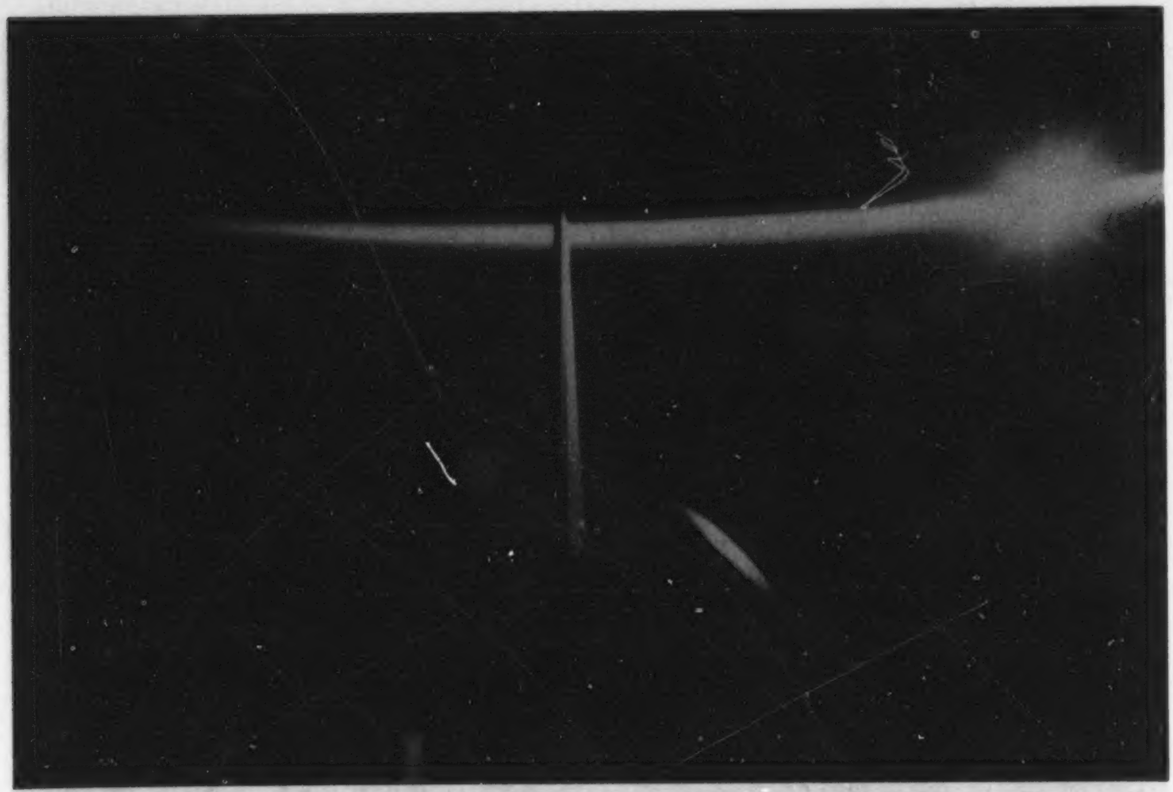
Earth views. Taken on Columbia's 49th orbit on flight day two (top photo), the closed empty protective shield for one of two earlier launched satellites is at lower left foreground. Orbit 64 on flight day five (bottom right); Columbia is silhouetted against the blue and white Earth.

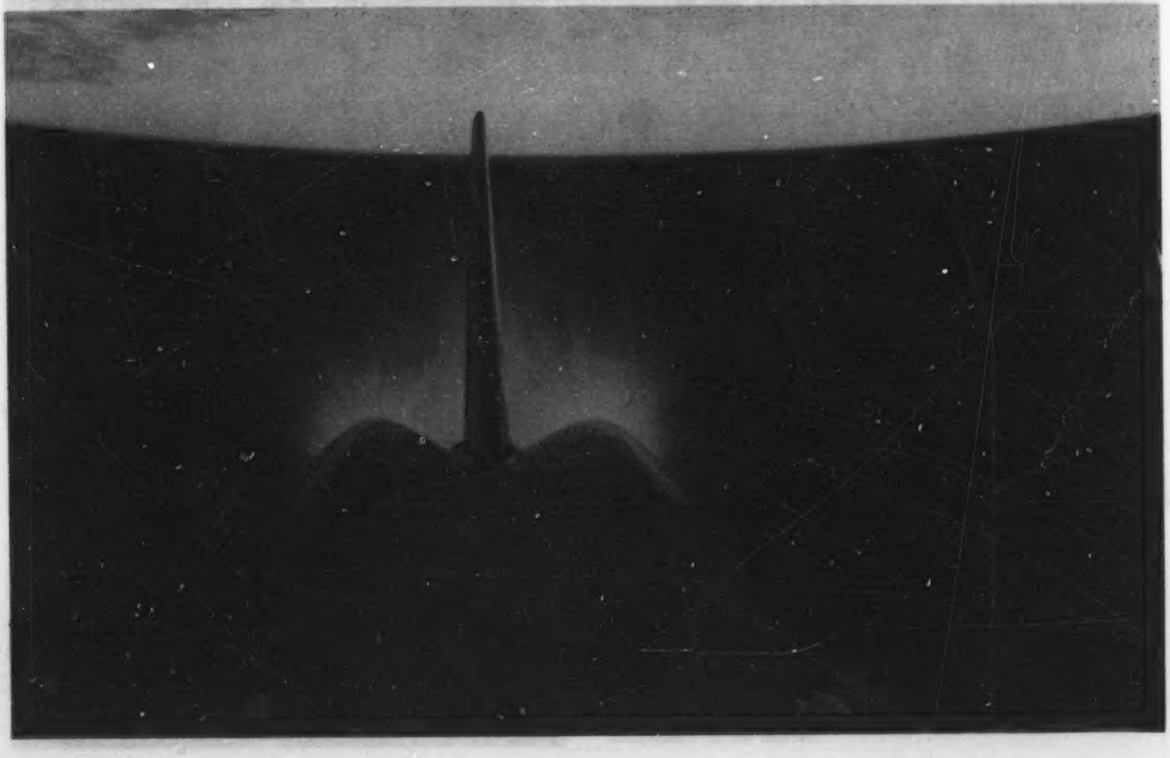
View of Lake Chad in Africa's Sahara Desert (photo at left) captured with a 70mm Hasselblad camera. The irregularly shaped dark patches show the impact of drought on the lake; lighter colored sand has encroached on the lakebed.

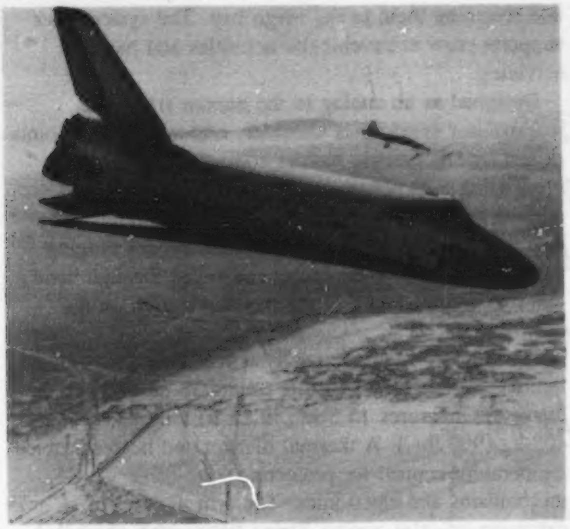


Satellite Business Systems-C spacecraft spins (at approximately 50 rpm) inside its protective cradle (top left) just prior to being spin released into space from Columbia's cargo bay. SBS-C was successfully deployed at 3:17 p.m. EST on flight day one of the mission. Photo at top right shows SBS-C spun out of the protective cradle by Columbia's new ejection system—a milestone for the Space Transportation System.

View of Anik-C spacecraft (bottom photo), deployed at 3:24 p.m. EST on Nov. 12 (flight day 2) as the spacecraft moves away from Columbia after deployment. This photo was taken through Columbia's aft windows.







United States

Space glow. Night scene of Columbia in orbit over the Earth's glowing horizon (top, p. 14) captured by a crew member aiming a 70-mm handheld camera through the aft windows of the flight deck.

Orbital maneuvering system engines are fired for a test burn (bottom photo, p. 14) causing a bright glow aft of the vehicle. This frame also was taken through the aft windows of Columbia's flight deck.

Columbia's final approach and landing on concrete runway 22 at Edwards Air Force Base, Calif., on Nov. 16. The orbiter successfully passed its first "hard braking" test. After the spacecraft had slowed to 140 knots with nose and landing gear down, maximum braking was applied to 80 knots and then light pressure was given until wheel stop. Rollout was about 9,500 feet. Mission duration for the fifth Space Shuttle mission was 5 days, 2 hours, 14 minutes and 25 seconds.

Shuttle 5 crew depart Columbia (bottom left); inspect the spacecraft (middle right); and speak to a crowd of press and well wishers at a post-landing ceremony.

Shuttle Remote Manipulator System Declared Operational

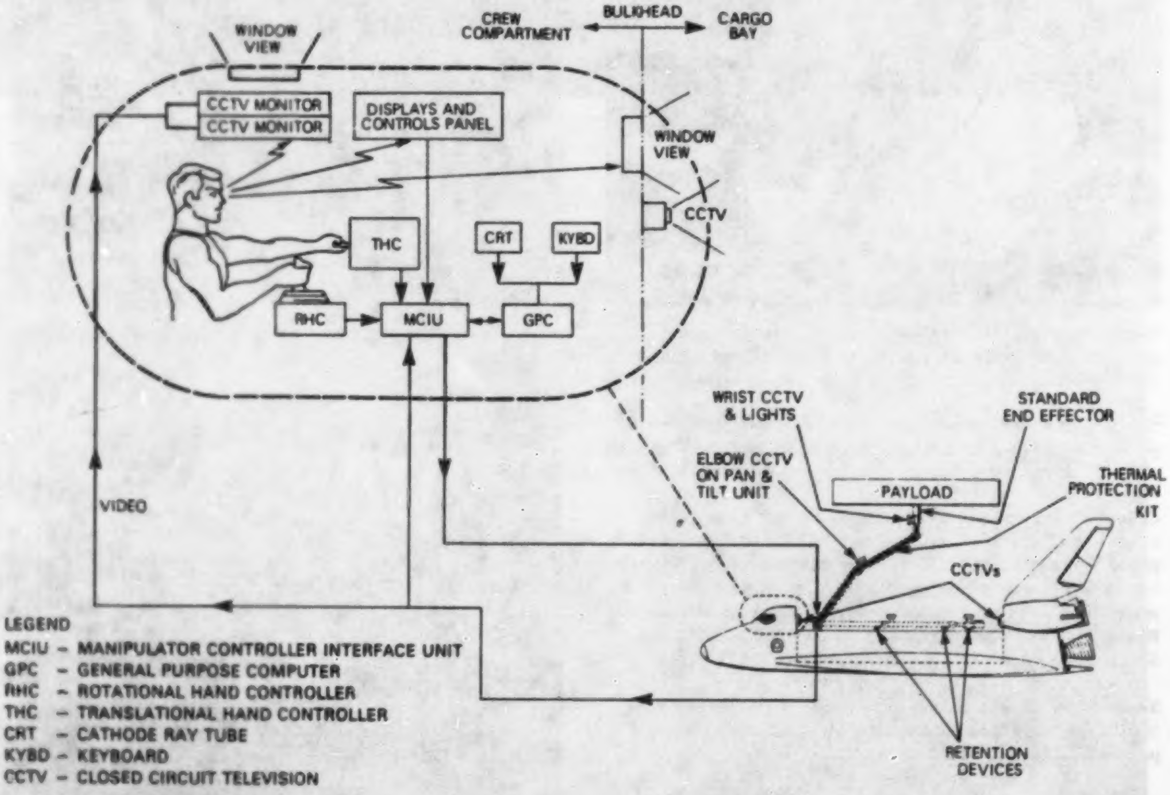
November marked the first operational flight of the Space Shuttle. At a formal ceremony held Nov. 3, another component of NASA's Space Transportation System was declared operational: the remote manipulator system. At this ceremony, NASA formally accepted the Canadian-built robotic arm from Canada's National Research Council as ready for operational use aboard future Shuttle flights.

The Remote Manipulator System, designed and built by a Canadian industrial team under a prime contract from the National Research Council of Canada to Spar Aerospace, Ltd., is the only mission critical orbiter subsystem originating from outside the United States.

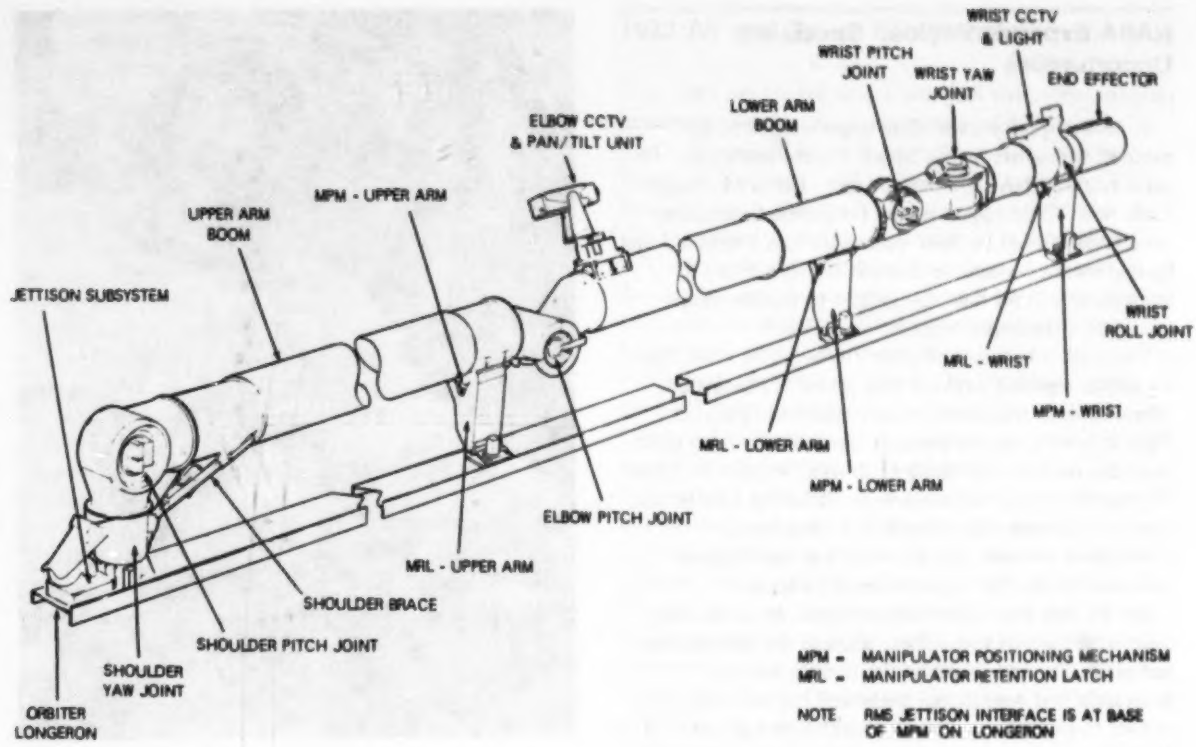
The Remote Manipulator System is a major subsystem of the Space Shuttle's payload deployment and retrieval system and is used for deploying payloads from the orbiter cargo bay, retrieving them from orbit and returning them to the cargo bay. The system also supports crew extravehicular activities and payload servicing.

Designed as an analog to the human arm, the manipulator system has shoulder, elbow and wrist joints driven by DC electric motors controlled by the flight crew using a combination of direct observation and television cameras on the elbow and wrist joints. The arm may be operated in five different modes ranging from full manual to computer controlled through hand controls and keyboard at the payload station on the orbiter flight deck.

The Remote Manipulator System is built of lightweight carbon composite tubing 38 cm (15 in.) in diameter, measures 15.3 m (50.25 ft) long and weighs 408 kg (900 lbs.). A thermal blanket and heater provide temperature control for protecting joint drive mechanisms and electronics. The arm underwent extensive on-orbit testing during the second, third and fourth flights of the Space Shuttle Columbia in November 1981, March 1982 and June 1982, respectively.


WINDOW VIEW
CREW COMPARTMENT
BULKHEAD
CARGO BAY
CCTV MONITOR
CCTV MONITOR
DISPLAYS AND CONTROLS PANEL
WINDOW VIEW
CCTV
THC
CRT
KYBD
RHC
MCIU
GPC
VIDEO
WRIST CCTV & LIGHTS
STANDARD END EFFECTOR
ELBOW CCTV ON PAN & TILT UNIT
PAYLOAD
THERMAL PROTECTION KIT
CCTVs
RETENTION DEVICES
LEGEND
MCIU – MANIPULATOR CONTROLLER INTERFACE UNIT
GPC – GENERAL PURPOSE COMPUTER
RHC – ROTATIONAL HAND CONTROLLER
THC – TRANSLATIONAL HAND CONTROLLER
CRT – CATHODE RAY TUBE
KYBD – KEYBOARD
CCTV – CLOSED CIRCUIT TELEVISION

Space Shuttle's remote manipulator system.


WRIST CCTV & LIGHT
WRIST PITCH JOINT
WRIST YAW JOINT
END EFFECTOR
LOWER ARM BOOM
ELBOW CCTV & PAN/TILT UNIT
MPM - UPPER ARM
UPPER ARM BOOM
JETTISON SUBSYSTEM
WRIST ROLL JOINT
MRL - WRIST
MPM - WRIST
MRL - LOWER ARM
MPM - LOWER ARM
ELBOW PITCH JOINT
MRL - UPPER ARM
SHOULDER BRACE
SHOULDER PITCH JOINT
SHOULDER YAW JOINT
ORBITER LONGERON
MPM = MANIPULATOR POSITIONING MECHANISM
MRL = MANIPULATOR RETENTION LATCH
NOTE RMS JETTISON INTERFACE IS AT BASE OF MPM ON LONGERON

Mechanical arm assembly of Space Shuttle's remote manipulator system.

Despite the shortened mission of the second Space Shuttle flight, primary test objectives designed to check the arm's operation and movements in space were achieved. System performance, interface between crew, hardware, and software, payload bay lighting and closed circuit television visual cues were evaluated during this flight and all were rated successful.

The third and fourth flights of Columbia continued the arm's evaluation, specifically its ability to handle the load and requirements of payload manipulation and the system's response to thermal tests. For flight three, the remote manipulator system grappled, deployed and berthed two experiments: the 160-kg (350-lb.) Plasma Diagnostics Package and the 363-kg (800-lb.). Induced Environment Contamination Monitor. Again system checkout was rated as successful.

For flight four, the Remote Manipulator System underwent its stiffest testing to date by lifting the Induced Environment Contamination Monitor up out of the cargo bay and moving this experiment package to various locations around the orbiter bay area to provide a more complete survey of the bay environment. These tests were successfully performed twice during the flight.

The first operational use of the Remote Manipulator System is scheduled for the seventh flight of the Space Shuttle in April 1983. The arm will deploy the German Shuttle Pallet Satellite (SPAS-01). Other planned uses of the robotic arm include grappling the Solar Maximum satellite for repair and deploying the Long Duration Exposure Exposure Facility (LDEF-1), both on flight 13 of the Space Shuttle currently scheduled for April 1984.

Development of the Remote Manipulator System, called "Canadarm" by the Canadian National Research Council, began in 1969 when NASA invited Canada to participate in the Space Transportation System program. In 1975 a Memorandum of Understanding was signed and in 1979 a contract was placed with Spai Aerospace Ltd., of Toronto, to manufacture the Remote Manipulator System.

NASA Expands Payload Specialist Opportunities

A revised policy expanding opportunities to fly payload specialists on the Space Shuttle has been announced by NASA Administrator, James M. Beggs. Until now, flight opportunities for payload specialists have been offered to those customers that purchased one half or more of a Shuttle mission or were flying a unique experiment that was judged to require unique talents of a particular scientist or engineer.

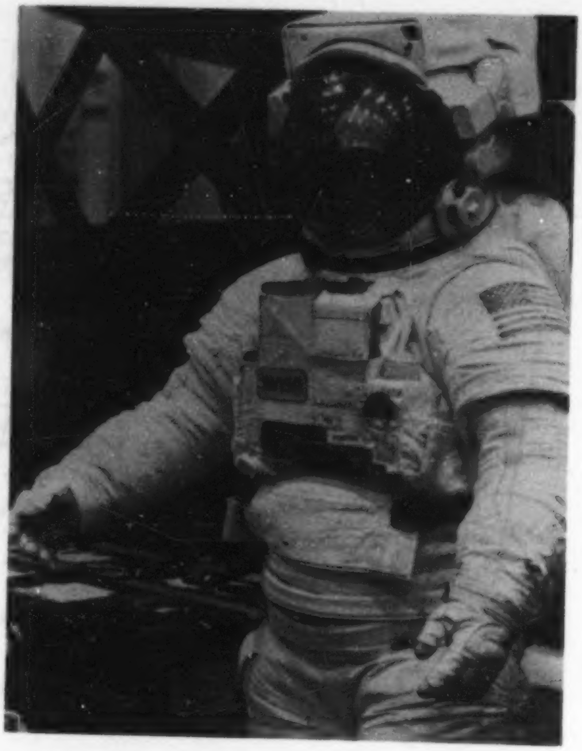
Under the expanded program, to begin in 1984, the minimum required payload load factor is eliminated. When mission requirements and manifesting permit, flight opportunities for payload specialists will be made available on a reimbursable basis to all classes of Space Shuttle major payload customers, including foreign and domestic commercial customers, international cooperative partners, the scientific and applications community, and the Department of Defense.

On the first four development flights of the Shuttle, there were two crew members aboard, the commander and pilot. The fifth flight of the Shuttle was the program's first operational flight and the crew expanded to four to include two mission specialists who assisted in deploying two commercial communication satellites.

In the future, mission specialists, who are experts in extravehicular activity, operation of the remote manipulator system and payload support systems, will be augmented by payload specialists on specific missions. These crew members will be added to selected flights to provide detailed, on-the-spot expertise concerning payloads or scientific experiments to help ensure mission success.

Payload specialists will most often be scientists, with special skills to operate a scientific experiment, or a specialist proposed by a Shuttle customer who is trained in the critical aspects of deploying and operating a satellite from the Space Shuttle or in the operations of a unique and critical processing experiment. Proposed payload specialists will undergo a short training program in preparation for space flight. NASA will retain the final selection authority to ensure that payload specialists are fully qualified and can safely function as part of the flight crew.

This expansion of the payload specialist policy proceeds toward an early major objective of the Space Shuttle program—for more people to go into space, easily and safely, in order to enhance the scientific, commercial and national security objectives there.



Space Suit Failure Investigated—NASA has formed an inquiry team at Johnson Space Center, Houston, to determine the cause of two separate extravehicular mobility unit (Shuttle space suit) failures that occurred during the fifth Space Shuttle mission. Mission specialist Lenoir's suit developed a problem with the primary pressurization system; the circulation fan in mission specialist Allen's suit failed to work properly. Results of the team's investigation are expected early this month.

International Customers for the Space Shuttle

Launch Services Agreements have been signed for flights aboard the Space Shuttle between NASA and The Federal Republic of Germany for launch of the German D-1 Spacelab, with the Arab Satellite Organization for launch of a telecommunications satellite, and with Mexico for launch of two communications satellites. In addition, Australia has notified NASA of its intent to use the Space Shuttle for the launching of two communications satellites.

Germany is the first country to purchase a dedicated Spacelab mission from NASA at a cost of approximately $65 million. The German D-1 Spacelab has been scheduled for launch aboard the Space Shuttle in June 1985. The D-1 mission will consist of low-gravity experiments in the field of materials processing in space and life sciences developed primarily by German industry, universities and other research institutions. Scientists from other European countries and the United States also are participating in experiments to be flown on the D-1 mission.

The German Ministry for Research and Technology has overall program responsibility for the D-1 mission; the German Aerospace Research Establishment has management responsibility.

This Launch Services Agreement, effective Sept. 29, 1982, continues a long history of close United States/German space cooperation. The Federal Republic of Germany has been a strong supporter of Space Transportation System utilization and contributed 64 percent of the funding for the billion dollar European development of Spacelab. Spacelab is a major element of the Space Transportation System with facilities and equipment similar to laboratories on Earth but adapted to zero gravity.

The Arab Satellite Organization, a consortium of 22 Arab countries, will operate a public satellite system for telecommunications and direct broadcast services for the member countries. The Arabsat-A spacecraft, built by Aerospatiale, Paris, France, and Ford Aerospace, Palo Alto, Calif., has been scheduled for launch aboard the Space Shuttle in October 1984.

NASA and Mexico signed a Launch Services Agreement on Nov. 24 which provides for the launch of two communications satellites from the Space Shuttle in April and September 1985, respectively. The satellite spacecraft will be built for the Mexican government by Hughes Aircraft Co., El Segundo, Calif.

Both Arabsat and Mexico will use a McDonnell Douglas payload assist module (PAM-D) to boost their spacecraft into a geosynchronous transfer orbit; a smaller rocket motor on the spacecraft will position the satellite in a circular geosynchronous orbit.

Australia has expressed an intent to launch two satellites called AUSSAT aboard the Space Shuttle, in July and October 1985, respectively. These satellites will be used for direct television broadcast, voice, data and public telephone services to continental Australia and off-shore territories. The satellites also will be built by Hughes.

1983 Air and Space Bicentennial

In 1983 the United States will join with other nations in commemorating the development of flight since man's first ascent in a hot air balloon at La Muette, France in November 1783. President Reagan and Vice President Bush will head the American celebration of this bicentennial marking 200 years of manned flight.

The President is scheduled to issue a proclamation in January, in conjunction with a joint Congressional resolution, to declare 1983 the year of air and space bicentennial events and to announce our country's full participation in these activities. The President heralds the 1983 celebration as an "unrivaled opportunity to honor U.S. achievements in aviation and space flight in a positive international environment."

America's participation in the 1983 air and space bicentennial will highlight this nation's growth in science, engineering and technology that has written aviation history and propelled man to the distant reaches of outer space in little more than 20 years. It also will be an opportunity to highlight the fact that NASA will celebrate its own 25th Anniversary in 1983.

A United States Organizing Committee has been established to plan, coordinate and assist in the implementation of national, state, and local festivities throughout the country. It will be the umbrella under which all U.S. air and space bicentennial activities will be organized and certified during the upcoming year.

The Committee chairman is Senator Charles Mac Mathias, Jr. (R-Md.), president is Major General Clifton F. von Kann, USA (Ret.), president of the National Aeronautic Association; and vice president is Anna Chennault, president, TAC International. Other members of the United States Organizing Committee include Senators Barry Goldwater (R-Ariz.), John H. Glenn (D-Ohio), and Congressman Don Fuqua, chairman, Science and Technology Committee.

NASA, the Federal Aviation Administration, the Department of Defense, the Department of Commerce and other governmental entities are supporting this committee in the American air and space bicentennial effort.

Events in the United States during 1983 will be programmed in regional clusters so that all parts of the country will have the opportunity to contribute to and benefit from the festivities. Washington, D.C., as the center of American government and the focus of international affairs in the United States, has been chosen as headquarters of the American air and space bicentennial effort.

The 1983 Air and Space Bicentennial celebration effort was formally inaugurated Nov. 8, the date of

Tribute to the 1983 Air and Space Bicentennial, live from Space Shuttle Columbia on flight day two of the fifth mission. Commander Brand holds up the logo commemorating the 200th anniversary of flight.

man's first flight, by President Reagan and Vice President Bush at a ceremony in Washington, D.C. Other participants in this ceremony included Congressman Fuqua, Senators Mathias and Goldwater and NASA Administrator James M. Beggs.

At this ceremony, Administrator Beggs outined the importance of NASA's role in the 1983 bicentennial celebration:

"It is fitting that NASA announce this celebration of 200 years of flight just three days before the Space Shuttle's first operational mission begins. For the Space Shuttle will do for space what the airplane has done for the air; make it an extension of our environment.

With the Shuttle going into business, we have the opportunity to make space an arena for the expansion of scientific, industrial and commercial activities. But more than that, we will have a tool for bettering our life here on Earth and new opportunities for international cooperation."

In a recent speech to the Wings Club in New York, Senator Goldwater outlined the five goals the 1983 bicentennial celebration hopes to achieve:

- to increase public awareness of the importance of aerospace to American economic development and national defense;
- to make the American public more knowledgeable about the needs of aerospace, particularly for strengthening research and development;
- to educate Americans on the importance of aerospace exports and why that means jobs;
- to emphasize the need to improve scientific and technical training in schools and colleges; and
- to rekindle the spirit of American excellence and enterprise and the importance of maintaining U.S. leadership.

A preliminary schedule of 1983 Air and Space events which will serve as opportunities to help celebrate the bicentennial in this country include:

January

U.S. Government proclamation of the Bicentennial Year

Parade and half-time mentions at the Super Bowl, Rose Bowl, Orange Bowl, Cotton Bowl and Sugar Bowl.

February

Space program retrospective at Kennedy Space Center, Fla.

Air Show and Exposition, Orlando and Disney World/Epcot Center.

March

Aerospace Symposium at Baltimore-Washington International Airport including Johns Hopkins University Space Telescope Institute, Baltimore, Md., and Goddard Space Flight Center, Greenbelt, Md.

April

Kennedy Center concert and multi-media gala, Washington, D.C.: music from Mozart to Star Wars, images from Montgolfier to the Moon, St. Exupery to Bradbury. Recorded and made into a commemorative album.

Air and Space Exposition, Houston International Airport, and NASA's Johnson Space Center.

May

National Air and Space Museum celebration and International Art Exhibition, Washington, D.C., May-Sept.

Gordon Bennett International Balloon Race, Los Angeles.

Air Mail and Commercial Pioneer Celebration, Newark International Airport, N.J.

The Airlines Move West, Exposition and Air Show, Chicago

June

U.S. coverage of the Paris Air Show and other events in France including filming of the air show for an American premiere later in the year.

July

International Balloon Rally on the Capital Mall, Washington, D.C.

Concordes and other supersonics, Dulles International Airport, Washington, D.C.

August

International Antique and Classic Airplane Fly-In, Oshkosh, Wisc.

The Treaty of Paris Trophy for Ultra-Light Aircraft, Annapolis, Md. to Glenn L. Martin Field, Baltimore.

New England Aero Club Air Show and Balloon Ascent on The Commons, Boston.

September

Annual meeting of the Federation Aeronautique Internationale, Los Angeles.

Aerospace Industry Rally, California.

Hollywood Salute to air and space, including premiere of the 1983 Paris Air Show film.

International Air Races, Reno, Nev.

International Balloon Rally, Albuquerque, N. Mex.

America's Cup Air Exposition, Newport, R. I.

October

Big Steel to Big Space; Pittsburgh celebrates the Bicentennial.

Wright Brothers Air Exposition, Kitty Hawk, N. Car.

November

Army-Navy football game, Philadelphia.

French Embassy reception to commemorate the first manned flight, (to be held Nov. 21, 1983).

December

Wright Trophy Annual Dinner, Washington, D.C.—80th Anniversary celebration of the first aircraft flight.

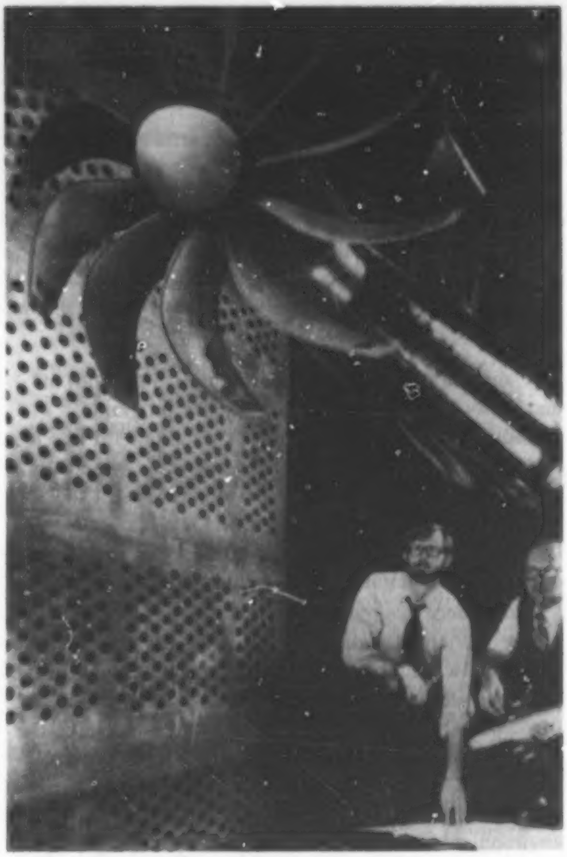
NASA Engine Technology Produces Fuel Saving Potential

A major milestone has been reached in the NASA Lewis Research Center's aircraft Energy Efficient Engine (E^3) program. Core testing (testing of the turbine engine that produces a hot gas stream) has demonstrated this engine concept will reduce fuel consumption by 14 percent and operating costs by 10 percent.

These results exceed original program goals in these two categories of 12 percent and 5 percent, respectively.

The E^3 program provides new technology for future advanced turbofan, turboprop and turboshaft engines for both commercial and military uses. Some of the new technology from the program already is appearing in new and derivative engine products such as honeycomb and Kevlar containment structures. These structures serve as safety net devices that surround the engine cylinder in the event of blade fractures.

The core of General Electric's E^3 engine has an all new 10-stage compressor with a 23:1 pressure ratio. A two-stage, high-pressure turbine incorporates advanced materials and aerodynamic design, and unique cooling techniques permit higher operating temperatures. Active clearance control, a low-emission combustor, and a full authority digital electronic control are part of the new design.



Wind tunnel test model of an advanced turboprop featuring multiple swept-tip propeller blades.

The Lewis-managed program is a $206 million, cost-shared effort involving the independent development of advanced technology engines by both General Electric and Pratt and Whitney. Approximately 90 percent of the total funding for both contracts is provided by NASA, and the balance by the two contractors. The program began in 1978 and will be completed in 1983.

Aeronautics research is a focus of work done at several NASA facilities: Lewis Research Center, Cleveland; Langley Research Center, Hampton, Va.; Ames Research Center, Mountain View, Calif.; and Dryden Flight Research Facility, Edwards, Calif. Lewis is NASA's lead center for aeronautical propulsion research.

Remarks by Burton I. Edelson
NASA Associate Administrator for Space Science and Applications

Public Session on Planetary Science and Public Policy

American Astronomical Society and the Planetary Society

Boulder, Colo.
October 19, 1982

In this short statement, I will address the health of and outlook for NASA's space science program, including planetary science and exploration. I'd like to say a few words about our goals, our strategy and approach, how we formulate the program, what the budget picture looks like, and how I see the future shaping up for space science in general and planetary science and exploration in particular.

Our science program is a scientifically sound, progress-oriented, balanced program—one that looks to the future while building on the outstanding work of the past. We are seeking answers to some of the most fundamental questions that can be asked concerning the origin and evolution of the universe. We study the universe at large using space techniques. We explore the planets. We study the Sun and the Sun-Earth environment. We study the Earth as a planet. We study living systems in space. And we use the vantage point of space to help solve major national problems and contribute to the economic environment. We do this to advance our understanding and develop new capabilities. We accomplish this through flight projects, research and analysis, and mission operations and data analysis.

To be successful in such a massive scientific and technical endeavor, we must bring to bear the best minds for consultation and guidance. For this reason, we consult with various advisory committees—the National Academy of Sciences Space Science Board, the Committee for Planetary Exploration, the Solar System Exploration Committee and the NASA Space and Earth Sciences Advisory Committee. We always pay attention to and frequently follow their advice.

It is necessary that we strike a balance in our space science program. We are concerned that the total program devote appropriate effort to several functional areas—astrophysics, planetary science, the earth sciences and life sciences. We are also concerned about balance in terms of mission size: for example, large facility class missions versus the smaller explorer class missions. Alternatives are constantly under review to ensure that the science program is ambitious and responsive, consistent with national needs.

The goals for all NASA programs, including space science, must be defined within the constraints of the general budget. This is an extremely complex process in which the various competing requirements vie for inclusion in the President's budget submission to Congress. We make a concerted effort throughout this process to ensure that we go forth with a progressive, balanced, carefully considered program—one that will build on the existing base and one that will preserve and enhance our scientific capability. Our space science program should provide options for future progress, and be realistic in terms of national economic conditions.

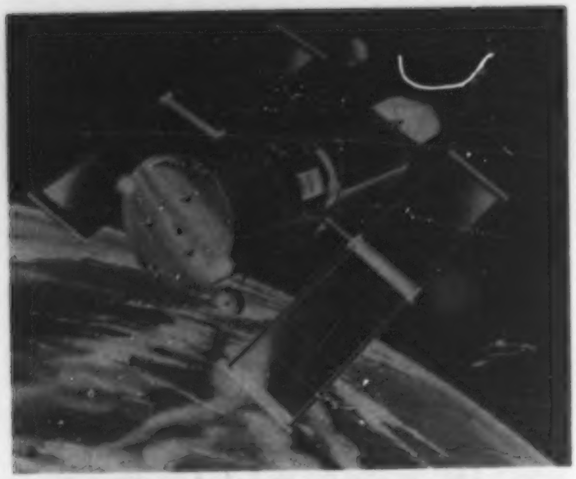
We have been successful in preserving our science base. We have charted an exciting and challenging space science program. I would like to outline some of the aspects of the current effort.

Overall, I maintain that the space science program is healthy. The administration is positively disposed toward a strong national space program. The President's policy statement on space recognizes the past achievements and is supportive of a continuing space science program. We have established effective links with the science community. We have achieved good interfaces and are working cooperatively with the Department of Defense. We have several major projects now in the development stage that show great promise. They will make enormous strides in advancing science. They excite the mind and they challenge engineering.

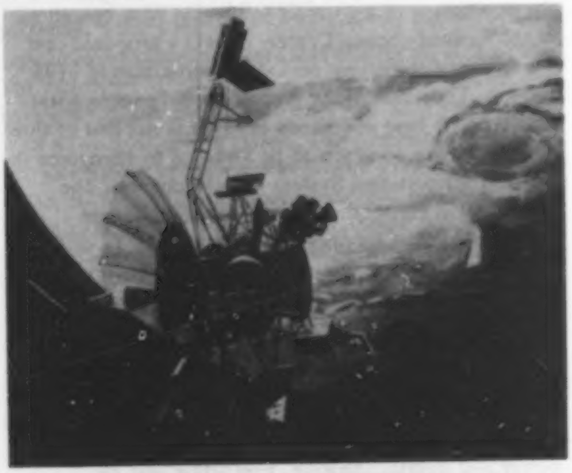
The **Space Telescope,** when launched in 1985, will be the most powerful observatory ever built. It will image astronomical bodies with at least seven times finer resolution than can be achieved by telescopes observing through Earth's atmosphere. It will detect objects fifty times fainter than the largest ground-base observatories. Space Telescope will support investigation of a wide variety of frontier problems in astrophysics.

Galileo, scheduled for launch in 1986, will carry out a thorough exploration of Jupiter, following up on the Voyager discoveries. The Galileo orbiter will provide imaging, remote sensing and magnetospheric measurements of Jupiter and its satellites. The atmospheric probe will obtain in situ measurements of Jupiter's chemical composition and physical state.

The **Gamma Ray Observatory,** planned for launch in 1988, will allow a penetrating look at the nuclear processes occurring near neutron stars and black holes. It will permit investigation of the formation of elements in supernovae, the origin of gamma-ray bursts, and



Artist concept of fully deployed Space Telescope. This instrument will enable scientists to gaze over seven times farther into space than ever before, to an approximate distance of 14 billion light years. The nearest star to Earth is 4 billion light years away; our current maximum ground observatory viewing range is about 2 billion light years. It is possible that Space Telescope will enable scientists to determine the parameters of the universe.



Artist concept of Galileo Orbiter releasing its atmosphere probe toward Jupiter to begin the first direct measurements of the planet's atmosphere. The spacecraft will conduct a 20-month scientific survey of Jupiter and its satellites.

details of the physical nature of recently discovered gamma-ray sources in the galaxy. Gamma Ray Observatory will move gamma-ray astronomy from infancy to a phase where we can begin the detailed study of the nuclear and elementary particle universe.

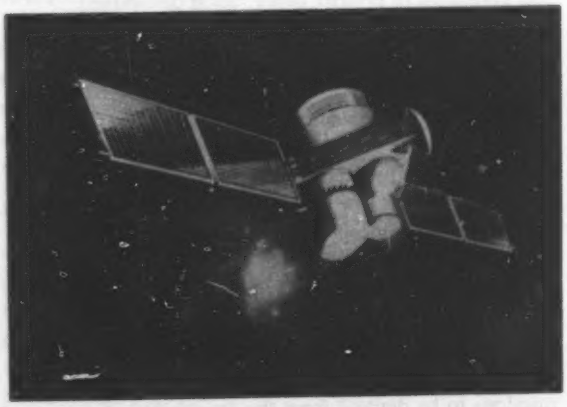
These major projects will make very important contributions to science, but we can't afford many such programs. So, we are also busy on smaller scale projects such as explorers. The infrared astronomical satellite will survey the outer solar system for asteroids. The Cosmic Background Explorer will observe details of the primeval explosion thought to have marked the beginning of the universe—the Big Bang. There are also a number of science payloads planned for the Space Shuttle—the Spacelabs, Solar Optical Telescope, Office of Space Science-3 and others.

In addition, we look forward to potential new missions in the next few years. These include the Venus Radar Mapper, the Upper Atmospheric Research Satellite, and a new class of low-cost planetary missions which we are calling "solar system observers."

We are investigating a wide spectrum of possibilities for planetary exploration. In this process we are depending heavily on recommendations of the Solar System Exploration Committee, which has noted the need for a balanced program and affordable implementation approaches. In my view, we are pointed in the right direction.

The budget picture is encouraging. The fiscal year 1983 appropriation for NASA is $6.8 billion, up 13 percent over fiscal year 1982. For space science and applications, the 1983 budget is $1022 million, up 14 percent over fiscal year 1982 budget of $896 million. Please think of those figures for just a moment. Over a billion dollars! Up 14 percent! That's certainly a great deal of money and a significant increase during this time of fiscal austerity when other departments, other budgets are being drastically reduced. It means that its program has support by the space agency, by the Administration, and by the Congress of the United States.

Planetary science has had some traumatic jolts in recent years. The cancellation of Venus Orbiting Imaging Radar and the American International Solar Polar Mission mission were difficult to take, particularly for those directly involved as program managers and scientists, investigators and contractors. But, these sad events are behind us. We are starting new programs and



Artist concept of Gamma Ray Observatory.

building up the science base to support them and we *are* continuing to cover past commitments. As you know we will support Pioneers 6 through 9, 10 and 11 and Pioneer Venus operations in fiscal year 83; we will keep the Lunar Curatorial Facility open; and we will operate the Infrared Telescope Facility. I promise to do my best in the future to keep all productive planetary operations going, keep the science base healthy, and win some new starts too. But it won't be easy and it can't be done without your help.

The effort for the fiscal year 1984 budget is now underway. I can't give you any specifics, but I can assure you that we have proposed a balanced and responsive program. I am optimistic concerning its approval, and foresee bright futures for space science and planetary exploration.

I mentioned earlier that we need to ensure that we get the best talent to advise and strategize in the space science program. It is important to develop a strategy that considers all of the factors that influence the program. Once the strategy has been developed we must be concerned with consistency and follow through. We are developing an effective strategy in each discipline area—astrophysics, planetary science, earth science, and life science. However, while each area can be separated as a discipline, they are all interdependent. We must produce an integrated space science strategy that, while recognizing the integrity of each of the elements, provides a balanced and survivable whole. The success of this process is significantly influenced by the quality of the product generated by our advisory committees.

Advisory committee recommendations to date have demonstrated high quality thought and analysis of proposed missions. A useful inventory of proposed missions has been generated. The planning and budgeting process will be greatly enhanced if committee recommendations are considered in a disciplined fashion and presented in priority order. Such disciplined recommendations will have great influence in the planning for fiscal years 1985-1988.

Our future space science program must be balanced, in the ways I have mentioned, and it must be constrained to fit the budget. It must also fit in with the rest of NASA's programs and strategies. For these reasons, we favor low cost planetary missions, ones that can fit into the concept of solar systems observers. We favor international cooperative missions, with the European Space Agency or with individual nations such as Canada or Japan.

NASA is developing the manned space station concept. There are potential benefits for science missions to be derived from the availability of a manned space station now being studied. It's important to consider these particularly for major planetary missions of the future. If ever we are to establish a lunar base or mount a Mars sample return mission for example, we will certainly need the staging base in low Earth orbit to do it. That base will be the space station. It is certainly not too early to consider that. My guess is that we will be ready to start a new major planetary mission, one larger than any attempted before, by way of the space station within five years.

The space science program is alive and well at NASA. We have built an outstanding record of achievement and continue to move forward as we approach the mid-1980s. The space station will support scientific endeavors. We've got outstanding people working on the science program. We've got public support. Over the long run we'll have the opportunity to do many things limited only by our imaginations. And I am happy to be able to play a part in this enterprise.

Contractor News

EG&G, Inc. of Wellesley, Mass., has been selected for negotiation of a contract to support base operations at the Kennedy Space Center. EG&G's proposed cost for an initial three-year period is approximately $193 million. The value of the contract could exceed $500 million. The base operations contract is the first of three comprehensive contracts to be awarded to strengthen the Space Transportation System launch function. The contract will consolidate institutional and certain technical support services now provided by 14 different contractors into a single mission contract covering utilities, facilities, administrative services, technical operations, and health and protective services.

Under the contract, for example, EG&G will be responsible for management of resources, information and data, maintenance, logistics, and energy. Under the utilities category, the company will be responsible for power and lighting; heating, ventilation and air conditioning; water and sewage; and administrative communications on the center. In other categories, the company will perform duties as disparate as roads and grounds maintenance, library services, graphics support, fire and physical security, handling and storage of rocket propellants and occupational medicine support. All services under the contract will be performed at Kennedy.

The cost plus incentive/award fee contract is for an initial period of one-year, plus two priced one-year options and seven unpriced one-year options for a total possible contract period of 10 years. The contract will take effect on Jan. 1, 1983.

Bendix Field Engineering Corp., Columbia, Md., has been awarded a $54 million contract by NASA for an 18-month period to provide maintenance, operations and management of the NASA Tracking and Data Relay Satellite System (TDRSS) ground elements. The contract includes two option periods totalling 42 months. Under terms of the contract Bendix will provide management, operations, maintenance, software support, systems engineering, and technical support of the NASA ground terminal at White Sands, N. Mex., and the Network Control Center and the Operations Support Computing Facility located at Goddard Space Flight Center, Greenbelt, Md.

The first Tracking and Data Relay Satellite System is scheduled for launch on board the Space Shuttle Challenger in January 1983. It will be the first of two satellites operating in geosynchronous orbit which will relay data from low-Earth orbiting satellites and the Space Shuttle to the single ground station at White Sands.

Calspan Field Services, Inc., Buffalo, N.Y., has been selected by NASA's Ames Research Center, Mountain View Calif., for negotiation of a contract to support wind tunnel facilities and auxiliaries at Ames. The estimated $10.5 million contract will be funded over a three-year period on a cost-plus-award-fee basis, with a two-year option clause. The contract provides services for the operation, inspection, maintenance and repair of the Ames 6×6-foot supersonic wind tunnel and auxiliaries, the 14×14-foot transonic wind tunnel and auxiliaries, the 12-foot pressure wind tunnel auxiliary equipment and the unitary plan wind tunnels auxiliary equipment. Total operation of tests performed in the 6×6-foot and 14×14-foot facilities is also part of the contract, as well as the design of wind tunnel models and related test equipment and the acquisition, inventory and control of spare parts and supplies.

Martin Marietta Aerospace, Denver, Colo., has been selected by NASA's Marshall Space Flight Center, Huntsville, Ala., for negotiation leading to a contract for detailed engineering analyses and selected advance development evaluations of a tethered satellite system concept. The value of the contract is approximately $1 million. If approved for final development, the tethered satellite system would be carried into orbit by the Space Shuttle in the late 1980s.

From the Shuttle cargo bay the satellite would be suspended downward on a tether up to 96 kilometers (60 miles) long, and would troll the Earth's upper atmosphere for magnetospheric, atmospheric and gravitational data. The satellite could also be deployed upward to study electrodynamic and other scientific phenomena.

NASA's Goddard Space Flight Center, Greenbelt, Md., has announced two contract negotiations: **Santa Barbara Research Center,** Goleta, Calif., has been selected to enter negotiations on a 42-month contract for a shortwave infrared detector array for future remote sensing satellites. The contract will approximate $5-6 million, and will cover the development of technology and the construction of the detector's focal plane (with 6,000 elements), as well as the testing and evaluation of the equipment. When developed, this detector array is expected to provide resolution in infrared wavelengths not possible in the past.

Federal Data Corp., Chevy Chase, Md., has been selected for negotiation of a contract for a flight dynamics computer system which supports the attitude determination, control and orbit maneuver computations for manned and unmanned spacecraft. The one-year contract, with options for four one-year options, is expected to approximate $7.1 million for the 5-year period.

From NASA's Johnson Space Center, Houston:

Grumman Aerospace Corp., Bethpage, N.Y., has signed a $1.8 million contract for a foot restraint platform that would allow space-walking Shuttle astronauts to be moved about by the orbiter's remote manipulator arm. Under the noncompetitive firm-fixed-price contract, Grumman will design and build two flight and two training restraints fitted with standard remote arm grapple fixtures similar to those fitted to Shuttle payloads planned for deployment or retrieval by the 50-foot-long robot arm. Called the interim manipulator foot restraint, the device will permit a spacesuited astronaut to be moved anywhere within the arm's reach without an umbilical tether.

NASA's Kennedy Space Center, Fla., has also awarded several contracts:

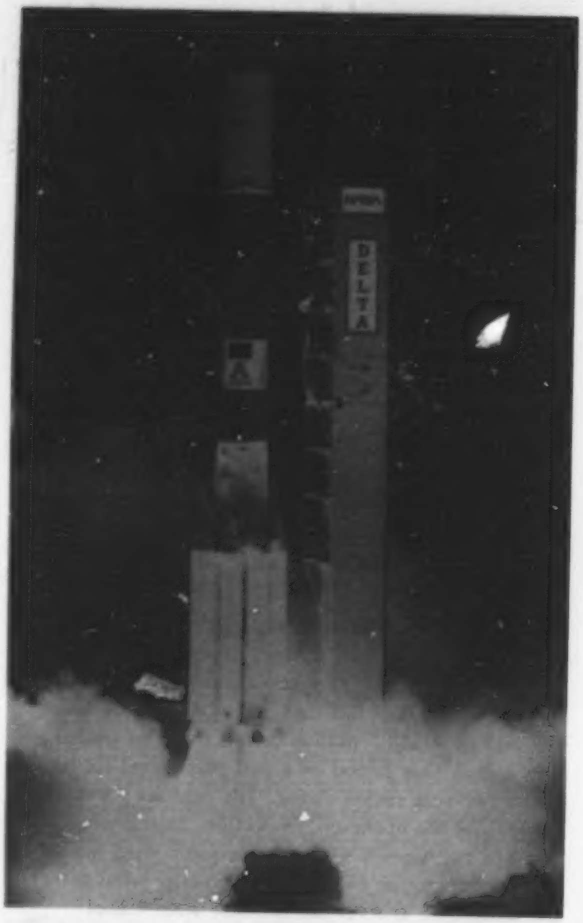
Computer Science Corp., Falls Church, Va., has been awarded a fixed-price contract valued at $7,781,723 for a Shuttle Inventory Management System to support the Space Shuttle program at Kennedy. The system will assist NASA in ensuring that spare parts, supplies and materials are available as needed to support the Shuttle program. The contract calls for delivery of automatic data processing equipment, communications equipment, and computer software. The award also provides for employment of software creation and maintenance personnel, and training of terminal users, computer operators and system controllers. The contract stipulates that the equipment will be installed and operational by August 13, 1984. It also provides for similar work to be performed at Vandenberg Air Force Base, Calif.

Holloway Corp., Titusville, Fla., has been awarded a $1.27 million contract to construct permanent environmental control system facilities at Kennedy which will be used for Shuttle orbiters while they are being processed and readied for flight in the Orbiter Processing Facility. Holloway will construct two equipment rooms to house an air-conditioning system which ensures the environmental stability of the orbiter. Presently, a mobile environmental control system is used for the orbiter as it is transported from one place to another for processing. The contract provides for the work to be completed by Sept. 30, 1983.

In other contract news, the Air Force Space Division has made a decision to join NASA in a procurement effort which will eventually lead to selection of a single contractor for the processing of the Space Shuttle at both the NASA Kennedy Space Center and Vandenberg Air Force Base launch facilities. NASA expects to issue a request for proposals for this joint effort in Jan. 1983.

Both NASA and the Air Force will consolidate contracts for flight hardware processing at both the Florida and California launch sites. At present, processing of Space Shuttle hardware is carried out at the launch site by several contractors who supply the flight hardware.

Originally the Air Force had not defined a time to phase in the Shuttle Processing Contract at the Vandenberg Air Force Base. It is now planned that the Shuttle processing contractor will be phased into Vandenberg processing as early as practicable and will be assigned launch responsibility in accordance with transition criteria. In accomplishing the phase-in, the Shuttle processing contractor will work with the incumbent launch site contractor at the Air Force Base.



1982's Last Expendable—RCA-E (Satcom V) lifts off aboard a Delta 3924 launch vehicle at the Eastern Space and Missile Center, Fla., at 9:27 p.m. EST on Oct. 27. This 24 channel satellite will provide telecommunications and video programming services within Alaska and between Alaska and the rest of the United States.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Atul Jain, Caltech/JPL	Multibeam single frequency synthetic aperture radar processor for imaging separate range swaths	4,355,311	NRO/JPL
An-Ti Chai, NASA/LeRC	Solar cell having improved back surface reflector	4,355,196	LeRC
Robert L. Altman, NASA/ARC	Synthesis of dawsonites	4,356,157	ARC
Eric G. Laue, Caltech/JPL	Cloud cover sensor	4,355,896	NRO/JPL
Kenneth L. Orloff and Haruo Yanagita, ARO, Inc., Tullahoma, Tenn.	Rhomboid prism pair for rotating the plane of parallel light beams	4,355,870	ARC

Expendable Launches for 1982

Name	Launch Date	Vehicle	Range	Mission Remarks
*RCA-C	January 15	Delta	ESMC	RCA communications. Reimbursable.
*Westar-IV	February 25	Delta	ESMC	Western Union communications. Reimbursable.
*Intelsat V-D	March 4	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*Insat 1-A	April 10	Delta	ESMC	India communications. Reimbursable.
*Westar-V	June 8	Delta	ESMC	Western Union communications. Reimbursable.
*Landsat-D	July 16	Delta	WSMC	NASA earth resources applications.
*Telesat-G (Anik-D1)	August 26	Delta	ESMC	Canada communications. Reimbursable.
*Intelsat V-E	September 28	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
*RCA-E	October 27	Delta	ESMC	RCA communications. Reimbursable.

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* Successful launch

Expendable Launches for 1983

Name	Launch Date	Vehicle	Range	Mission Remarks
Intelsat V-F	January 27	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.
IRAS	January 27	Delta	WSMC	Infrared astronomy. NASA scientific.
NOAA-E	February	Atlas-F	WSMC	NOAA weather and SARSAT. Reimbursable.
RCA-F	March 31	Delta	ESMC	RCA communications. Reimbursable.
NAVY-21	2d quarter	Scout	WSMC	DOD transit. Reimbursable. Call up.
GOES-F	April 28	Delta	ESMC	NOAA weather. Reimbursable.
San Marco D/L	May	Scout	SMR	International cooperative/Italy.
HILAT	June	Scout	WSMC	Air Force research and development. Reimbursable.
Galaxy-A	June	Delta	ESMC	Hughes Communications, Inc. Reimbursable.
Telstar-3A	July 28	Delta	ESMC	AT & T communications. Reimbursable.
RCA-G	August 25	Delta	ESMC	RCA communications. Reimbursable.
AF-1	August	Scout	WFC	Air Force development program. Reimbursable.
NOAA-D	August	Atlas-F	WSMC	NOAA weather. Reimbursable.
Galaxy-B	September 15	Delta	ESMC	Hughes Communications, Inc. Reimbursable.
NATO IIID	October	Delta	ESMC	NATO communications. Reimbursable.
NAVY-22	4th quarter	Scout	WSMC	DOD transit. Reimbursable. Call up.
AF-2	December	Scout	WFC	Air Force development program. Reimbursable.
Intelsat VA-A	December	Atlas Centaur	ESMC	Intelsat communications. Reimbursable.

Space Shuttle Launches for 1982

Orbiter	Launch Date	Launch Site	Payload
*Columbia (OC-102)	March 22	KSC	OSS-1
*Columbia (OC-102)	June 27	KSC	DOD 82-1
*Columbia (OV-102)	November 11	KSC	SBS-C/Anik-C

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* Successful launch

Space Shuttle Launches for 1983

Orbiter	Launch Date	Launch Site	Payload
Challenger (OV-099)	January 24	KSC	TDRS-A
Challenger (OV-099)	April 20	KSC	OSTA 2: SPAS-01 Telesat-F: Palapa B-1
Challenger (OV-099)	July 4	KSC	INSAT 1-B: TDRS-B
Columbia (OV-102)	September 30	KSC	Spacelab 1
Challenger (OV-099)	December 14	KSC	DOD 84-1

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Forestry Land Crawler

An unmanned land rover originally developed by NASA for use on the Moon has been given an Earth-based application as a forestry vehicle.

During the Apollo program, NASA's Johnson Space Center developed plans for a remotely controlled all-terrain vehicle that could roam the Moon's surface and report data back over a long period. In NASA's design for this vehicle was a load equalization suspension that would allow the vehicle to cross lunar craters, or boulder fields or to climb steep slopes. This special suspension was designed to keep all four wheels on the ground regardless of the difficulty of the terrain—whether the vehicle was pitching sharply up and down or rolling from side to side.

This unmanned rover never became operational for NASA's lunar application. But use of NASA's suspension technology by the University of California, Davis, in cooperation with the California Department of Forestry, produced Power Pack II,* a land rover that provides an economical way of moving a power source into remote roadless, forested areas.

Foresters need power to run equipment for such operations as logging, planting, pumping water and building trails. Helicopters or specially designed "skidders" are expensive; human haulage is limited to relatively light, low-power equipment. Power Pack II fills this gap, providing both a power source and a method of transporting varying weight power tools to a forestry site.

Power Pack II can traverse very rough terrain and climb a 60 degree slope; any one of the wheels can move easily over an obstacle larger than the wheel's own diameter. Plans for a more advanced Power Pack III are underway.

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* NASA does not endorse commercial products as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.

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